instruction

manual

TRANSISTORIZED DIGITAL VOLT-OHM-RATIOMETER

MODELS M-24 and V-24

(NLS PART NUMBERS 10050 and 10056)

NLS

non-linear systems, inc. SAN DIEGO COUNTY AIRPORT, DEL MAR, CALIFORNIA

non-linear systems inc.

I. A. Sarell

M24 - 1 mV
V24 - P.N. 10019 } 125 CONV.

NLS MODEL 24
TRANSISTORIZED DIGITAL
VOLT-OHM-RATIOMETER

M24 - .1 mV
P.N. 10050 } 125 C
125 E
after the M24 is modified

non-linear systems inc.

I. D. Sanell

<u>NOTICE</u> - FOR MODEL V24

MODEL V24 IS IDENTICAL TO MODEL M24 EXCEPT THAT THE V24 DOES NOT MEASURE RESISTANCE. OTHERWISE, EVERYTHING IN THIS HANDBOOK APPLIES TO MODEL V24, AS WELL AS TO MODEL M24.

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Model M24 100 Microvolt Sensitivity

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SECTION I - GENERAL DESCRIPTION

GENERAL:

The Model M-24 Transistorized Volt-Ohmmeter is a high speed four digit instrument designed specifically for systems checkout. The high accuracy, speed, and reliability of the instrument are obtained by the utilization of semiconductors and mercury wetted relays. The measured voltages, ratios, or K-ohms, as the case may be, are displayed on the new, easily removable, edge lighted readout developed by Non-Linear Systems, Inc.

The logic circuits of the instrument, which are made up of transistors and diodes, are duplicated many times in the instrument. Because of this, it has been possible to use identical plug-in units, thereby simplifying the stocking of spare parts. Furthermore, the plug-in units have been made so that the computing and readout storage of each decade is contained in one unit. This is a useful feature in diagnosing malfunction in the computing processes of each decade. (See SECTION V).

Many desirable features of other NLS digital instruments are retained in the Model M-24. These include high input impedance, automatic range and polarity selection, and the ability to operate card punches, electric typewriters, and other printing devices. The Model M-24 is also equipped for use with an NLS Model 125 AC-DC Converter if accurate AC voltage measurements are desired.

Original features of the Model M-24 are:

1. High computing speed, 3 per second.

2. Multipurpose - measures volts DC, DC voltage ratios, and DC resistances (non-reactive).

3. Removable readout (See SECTION V - Maintenance and Trouble Shooting).

4. Long readout bulb life - All readout bulbs of the Model M-24 are powered by a regulated supply and switched by transistors, thus greatly limiting the surge current of a cold bulb filament.

5. Remote or local control of "Scan" command and/or function selecting. (See SECTION II - Remote Control Operation.)

SPECIFICATIONS

INPUT IMPEDANCE:

1.	VOLTS DC	-	10 megohms
2.	RATIOS	-	1000 megohms
3.	K-OHMS	-	Does not apply (input is one leg of a Wheatstone)

REFERENCE:

1.	VOLTS DC	-	Temperature controlled, zener diode stabilized reference source.
2.	RATIOS	-	External ±1 VDC minimum to ±100 VDC maximum (Ripple content should be less than .01% of the Reference.)
3.	K-OHMS	-	Internal, zener reference source.

RANGES:

VOLTS D. C., Automatic

a.	±.0000	-	±.9999 VDC
b.	±1.000	-	±9.999 VDC
c.	±10.00	-	±99.99 VDC
d.	±100.0	-	±999.9 VDC

RATIO

±.0000	-	±.9999

K-OHMS, Automatic

a.	.0000	-	.9999 Kilohms
b.	1.000	-	9.999 Kilohms

c. 10.00 - 99.99 Kilohms

d. 100.0 - 999.9 Kilohms

VOLTS A. C., Manual

a. 0.000 - 9.999 VAC

b. 10.00 - 99.99 VAC

c. 100.0 - 999.9 VAC

ACCURACY

VOLTS DC: ±1 digit, calibrated against certified NLS factory standards. Deviations which can occur with time include:

LINEARITY: ±1 digit.

SCALE MULTIPLIER: ±0.01% of reading.

STANDARIZATION: ±0.01% of reading.

Screwdriver type calibration controls permit bringing instrument into agreement with your voltage standards.

RATIO: ±1 digit.

OHMS: ±(0.05% of reading + 1 digit).

PRIMARY POWER

115V ±10V AC at 60 cps with earth ground available.

OPERATING TEMPERATURE

$+32^{\circ}$F. to $+125^{\circ}$F. ambient.

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SECTION II - OPERATING PROCEDURE

INSTALLATION

GENERAL:

The Model M-24 digital multi-purpose meter consists of two modules, each 5-1/4" high and designed to be installed in a standard 19" rack or cabinet. Both modules are completely enclosed and can be operated on the bench.

The logic module (or "A" unit) contains the Wolff-Poggendorf bridge and the transistorized logic circuits that operate it. The "A" unit is identified by the readout on the front panel. The power and sensing module (or "B" unit) contains the power supply, the reference source, the sensing amplifier, and range and function switching relays. This unit is identified by the control knobs on the front panel.

Special precautions should be taken as to the physical attitude of the units. Both units contain mercury-wetted relays which cannot be operated at an angle of greater than 30° off of vertical. Therefore, after installation has been completed, the front panels should be within $\pm 30°$ vertical.

Upon completion of installation, check to see that there is sufficient clearance for cooling air circulation. The cooling louvers should not be restricted in any way.

CABLE CONNECTIONS:

1. Connect the following inter-connecting, input, and control cables to the "A" and "B" units.

PURPOSE	PLUG IDENTITY	LOCATION
Power and logic	50 pin Winchester	A unit to B unit
Feedback	5 pin "AN" Connector	A unit to B unit
External Reference	4 pin "AN" Connector	B unit to external reference volts
Input	3 pin "AN" Connector	B unit to unknown input
*Printer Intelligence	75 pin Winchester	A unit to print device or remote readout
**AC-DC Converter Control	34 pin Winchester	B unit to AC-DC Converter

*This cable is supplied only with a printer, adapter, or remote readout.

** This cable is supplied only with an AC-DC Converter; otherwise, a plug is supplied which must be installed. The plug contains jumpers necessary to the operation of the meter. The plug can also be wired to provide remote function control, as shown in Figure 2-1.

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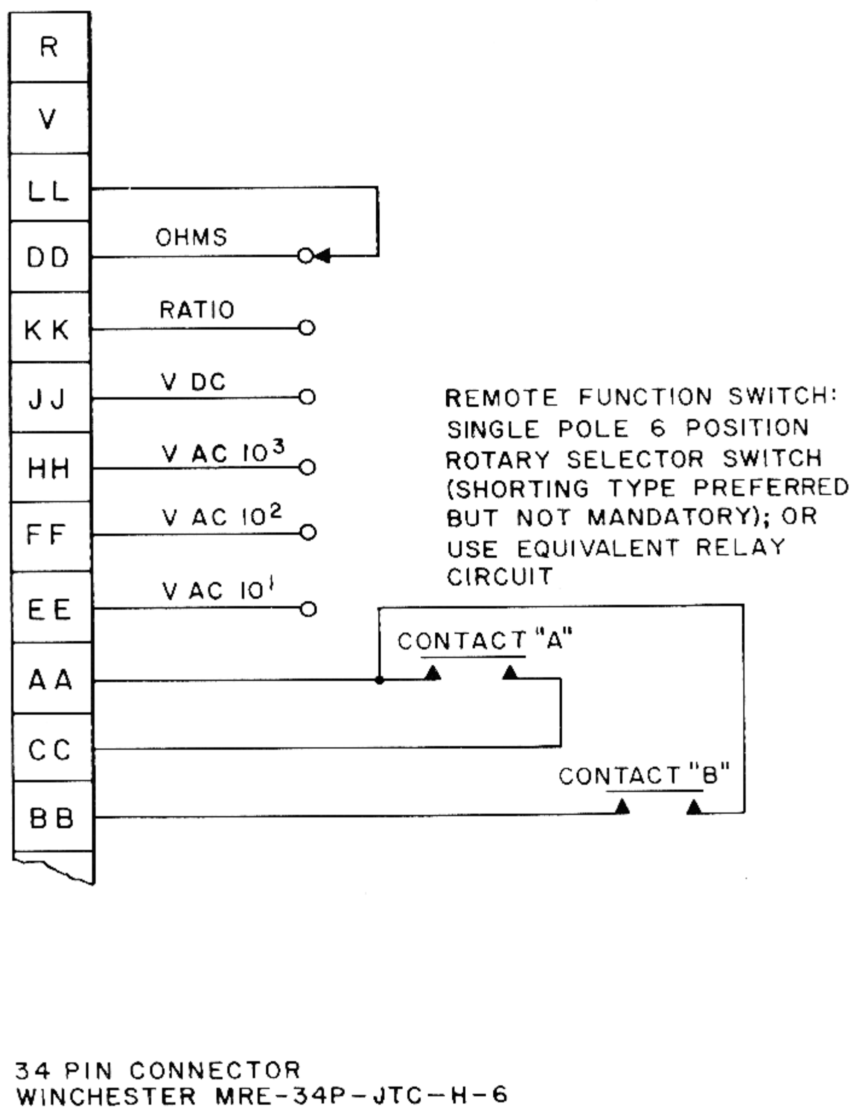


FIGURE 2-1. REMOTE CONTROL CONNECTIONS

2. Connect the external reference cable to the reference voltage, as follows:

   Red clip lead (Pin A) to + voltage.

   Black clip lead (Pin C) to reference ground (reference common).

   Red-black clip lead (Pin B) to - voltage.

   The reference voltage can be any magnitude from ± 1 VDC minimum to ± 100 VDC maximum. Loss of accuracy will result if these limits are exceeded.

   CAUTION: Do not connect the external reference, or have the POWER switch "ON" if the "A" unit is not in the proper operating position. If the "A" unit is tilted over 30° in either case, the external reference supply and/or the "B" unit may be damaged.

PRIMARY POWER:

The Model M-24 is designed to operate from 105 to 125 volts 60 cps power source. The instrument is supplied with a polarized power cord to utilize earth ground. It is important that the polarization of the power receptacle is correct and that earth ground is present. In all models, earth ground of the power cord is connected to the chassis ground of each module.

Adverse line conditions, such as amplitude modulation and line transients (caused by motors, arc welders, thyratrons, etc.) may affect the accuracy of the meter. Therefore, it is recommended that line filters be used if the power source is not reasonably clean.

FUSING:

The Model M-24 is provided with four fuses located at the rear of the instrument.

1. The line fuse is a 3AG slo blo rated at 3 amperes which protects the instrument from high voltage, line overload, and/or shorts.

2. The power supply fuse is an 8AG 3 amp instrument fuse which protects the low voltage power supply from sudden overloads. (Not shown on Fig. 5-2)

3. Spare 3AG slo blo 3 amp fuse.

4. Spare 8AG 3 amp fuse. (Not shown on Fig. 5-2)

FRONT PANEL CONTROLS

POWER SWITCH:

1. Controls the 115 VAC 60 cps primary power to the instrument. Power is applied to the instrument for both "ON" and "PRINT" positions.

2. Controls the print command pulse and printer operation as follows: When the power switch is in the "Print" position, a ten millisecond pulse (-15 VDC at up to 1 m. a. load) occurs at the end of the meter scan (the pulse appears at Pin #49 of the 75 pin connector at the rear of the "A" unit). This pulse is utilized to actuate the print recording device. Quiescent voltage is approximately - 2. 5 VDC. Also, on the "Print" position, a momentary single pole double throw contact closure must occur in the printer to operate the meter in "Continuous" mode, (See description of MODE switch).

FUNCTION SWITCH:

1. Ratio Position - For the purpose of measuring DC voltage ratios according to specifications. (See INSTALLATION - Cable Connections - For Reference Voltages).

2. Ohms position - For the purpose of measuring non-reactive resistance values according to specifications. Ohms position is also used to actuate the remote function selection circuits. (See Remote Control Operation).

3. VDC - For the purpose of measuring Volts DC according to specifications.

4. VAC - position 100-1000, 10-100, and 0-10: Measures volts AC when the Model M-24 is used in conjunction with an AC-DC converter. Ranging is manual, depending on the switch position selected.

MODE SWITCH:

1. Continuous - This position allows the meter to scan repeatedly at a rate of 3 times per second. If the POWER switch is in the "Print" position however, the meter will not scan a second time until "End of Print" information (in the form of a momentary, 10 m. s. min. , SPDT contact closure) is received from the printer.

2. Standby - When the switch is placed in this position, the meter will complete the present scan and stop until a new scan command is given by momentarily placing the MODE switch to the "Single Scan" position.

OPERATION

After the instrument has been installed and the operator has familiarized himself with the front panel controls, proceed as follows:

1. Set the POWER switch to "Off"; the FUNCTION switch to "VDC"; and the MODE switch to "Continuous Scan".

2. Short the input leads together.

3. Connect the primary power cord to a 115 VAC 60 cps polarized outlet.

4. Set the POWER switch to "On". The readout should illuminate, and the instrument should start scanning immediately. Scanning can be detected by a periodic blinking of the readout.

5. After approximately one minute's warm up time, the instrument will read out ± .0000.

   NOTE: If the readout is reading -.0000, only the decimal will blink once each scan. (This is because the readout is reading the numbers and polarity corresponding to the reset state of the readout storage circuits.)

6. Allow an additional fifteen minutes of warm up time before making any precision readings.

7. Set the MODE switch to "Standby", the FUNCTION switch to the particular type of reading to be taken, and connect the input leads to the unknown being measured. The reading can now be made once by momentarily setting the MODE switch to "Single Scan", or repeatedly by setting it to "Continuous Scan".

CAUTION: Damage may result if voltages greater than the following are applied to the input terminals of the instrument:

1. ±20 VDC or VAC with function switch on "Ohms".

2. ±300 VDC with function switch on "Ratio" and "VAC".

3. ±300 VDC with function switch on "VDC" unless the instrument is scanned immediately.

4. 110 VAC with the function switch on "VDC".

CAUTION: Do not attempt to measure the 115 VAC 60 cps line voltage while on D. C. function or on VAC unless caution is taken as to the polarization of the input leads.

Because of the high speed operation of the instrument, no input filter is incorporated; therefore, if the input is modulated or noisy, the reading will indicate some value between the plus and minus peaks of the input modulation.

REMOTE CONTROL OPERATION:

1. Function Selecting: Set the front panel FUNCTION switch to the "Ohms" position. If the 34 pin connector at the rear of the "B" unit is wired per Figure 2-1, function control of Model M-24 is transferred to the remote function switch. Any function desired can be selected by turning the remote function switch to the proper position.

2. Mode Control: Set the Mode switch to the "Standby" position. Any mode of the MODE switch can now be duplicated as follows:

   a. Single Scan Operation can be remotely actuated by a momentary closure (10 m. s. min.) of contact "A" as shown in Figure 2-1. Contact "A" should be opened for at least 10 ms. before reclosing.

   b. Continuous scan can be obtained by a continuous closure of contact "B" (Figure 2-1).

PRINT RECORDING OPERATION:

All of the information displayed on the readout is wired to the 75 pin connector located at the rear of the "A" unit. This information appears as a -0. 5 VDC on the pin representing the digit or intelligence being transmitted to the recorder. All digits not transmitting information have a quiescent voltage of - 27 VDC on their respective pins.

External connections to the 75 pin connector should be made using the - 27 VDC line as a common. The unit is then energized when the bulb is lit in the readout and the external load is on the readout buffer. Available current for external devices is 5 m. a. If the readout is removed, 45 m. a. (non-reactive) can be obtained. If it is desired to connect to ground as a common, the load will be in series with the readout bulb and the current will be limited to 20 m. a. However, because there are approximately 40 bulbs not lit and, therefore, a possible 40 energized loads with common ground, the load would be too great. Maximum total current from the plug should be limited to 200 milliamps.

Printing heads are available, through NLS, which plug directly into the 75 pin connector. Also, this type of intelligence can be used to drive an electronic Serial Converter for typewriters, etc.; otherwise, Parallel or Serial Adapters, utilizing relays are used to convert the outputs from voltage representation to contact closures. The printing device is then connected to the Adapter.

With all types of printing systems, proceed as follows:

1. Connect the entire print recording system to the Model M-24., For a continuous print mode of operation, the printer being used should have a momentary SPDT contact closure, actuated for 10 m.s. (min.) when the printing is completed. This is mentioned in case the operator is to use a printer other than one supplied by NLS.

2. After the instrument has been allowed to warm up, set the MODE switch to "Standby" and the POWER switch to "Print", in that order. All front panel and remote control operation remains the same except, possibly, the "Continuous Scan" mode. It may be necessary to actuate the "Single Scan" mode O N C E before setting for "Continuous Scan".

   This allows a capacitor in the "B" unit to charge, which will insure operation of the "Continuous" mode.

   Because the meter now "waits" for the printer, the scanning period will change. Therefore, depending upon the speed of the printer being used, the number of readings taken per second will drop when the operator switches to the "Print" position of the POWER switch.

REMOTE READOUT:

The 75 pin connector at the rear of the "A" unit can also be used to connect a remote readout. The Model M-24 readout circuits are not designed to accommodate two readouts; so the local readout must be removed before connecting the remote readout. (See Section V - Maintenance and Trouble Shooting.)

CAUTION: Do not attempt to remove or install the local readout with the POWER on as this may damage the low voltage power supply.

SECTION III - CIRCUIT DESCRIPTION

GENERAL:

The Model M-24 fundamentally is a digital voltmeter with the proper variation of circuitry required to enable it to read DC ratios and ohm resistance value. Basically, it is a self-balancing potentiometer utilizing a differential amplifier, a precision feedback bridge, bridge controlling circuits and readout memory circuits. When the amplifier has attained a balanced input, the feedback voltage of the bridge is represented by a digital indication on the readout. (See GENERAL BLOCK DIAGRAM, FIGURE 3-1)

The input to the amplifier utilizes a chopper as a comparison device. The output of the chopper is a square wave that has a magnitude (peak to peak) proportional to the difference of the DC levels of the input voltage and the feedback voltage. This square wave is amplified and connected directly to the Scan Logic circuits (See Figure 3-1).

AMPLIFIER:

The amplifier is a three tube differential amplifier. The input to the amplifier, which is the output of the chopper, is directly coupled to the grid of a 5751 vacuum tube. This 5751 is connected to represent a cathode coupled amplifier stage (See Figure 3-2). The circuitry of the 5751 has the characteristic of giving an output proportional to, and in phase with, the input. This tube has to be capable of amplifying a 0.1 millivolt p-p square wave at DC levels ranging from + 10 VDC to - 10 DC. Therefore, the feedback level is connected to Pin 7 of the 5751. The output of the 5751 is capacity coupled to the input of the 5879 pentode and to the "restoring" reed of the chopper.

The output of the 5879 is DC coupled to the 6201 cathode follower output tube. The 5879, having no input grid leak, represents a high gain non-blocking amplifier. In order to prevent excessive drift, the output of the last cathode follower is shorted directly to the input of the 5879 for one half of each chopper cycle. This restores the input and output to a fixed level determined by the circuit parameters. The restoring is done during the time the input reed of the chopper is on the feedback contact; therefore, the 5751 is looking at zero error and the .0047 mfd capacitor charges to a potential which is the difference between the quiescent output voltage of the 5751 and the restored output of the amplifier. When the chopper is transferred to the input, the restoring circuit is opened and the amplified error signal is applied through the coupling capacitor to the grid of the 5879. Now the output will be a square wave, one peak of which will be at the restored level (approximately - 1 V) and the other proportional to the input error.

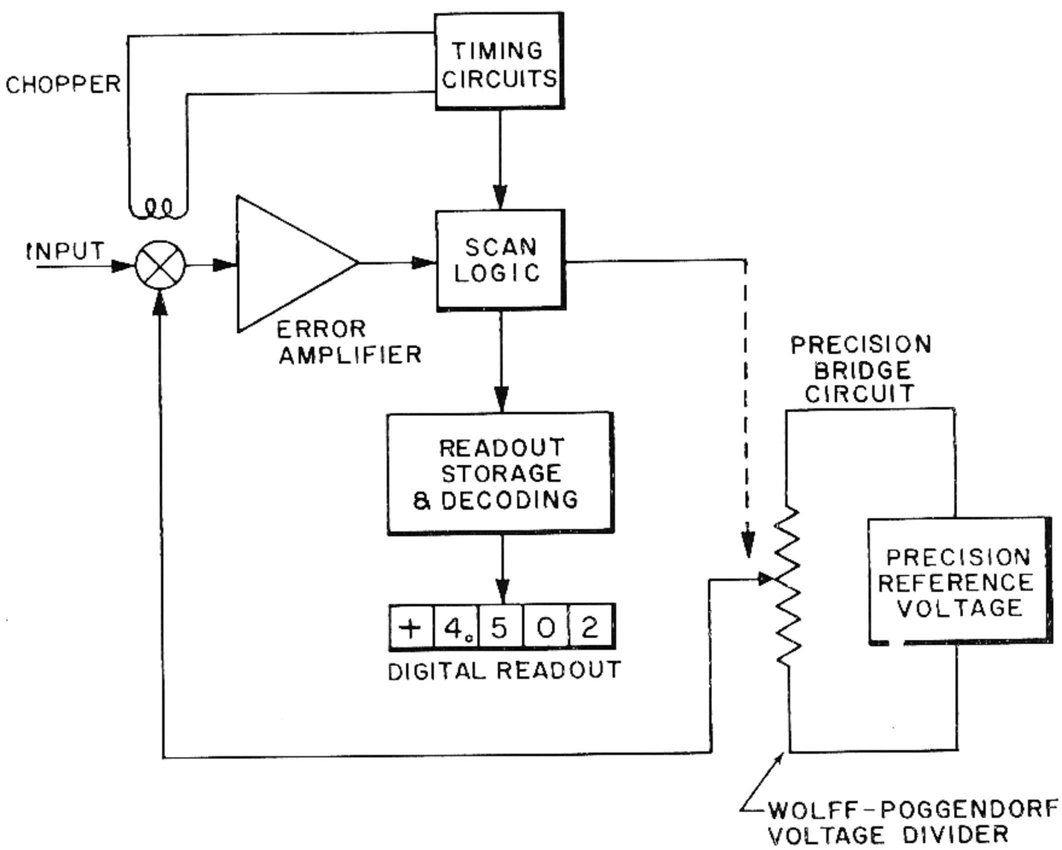
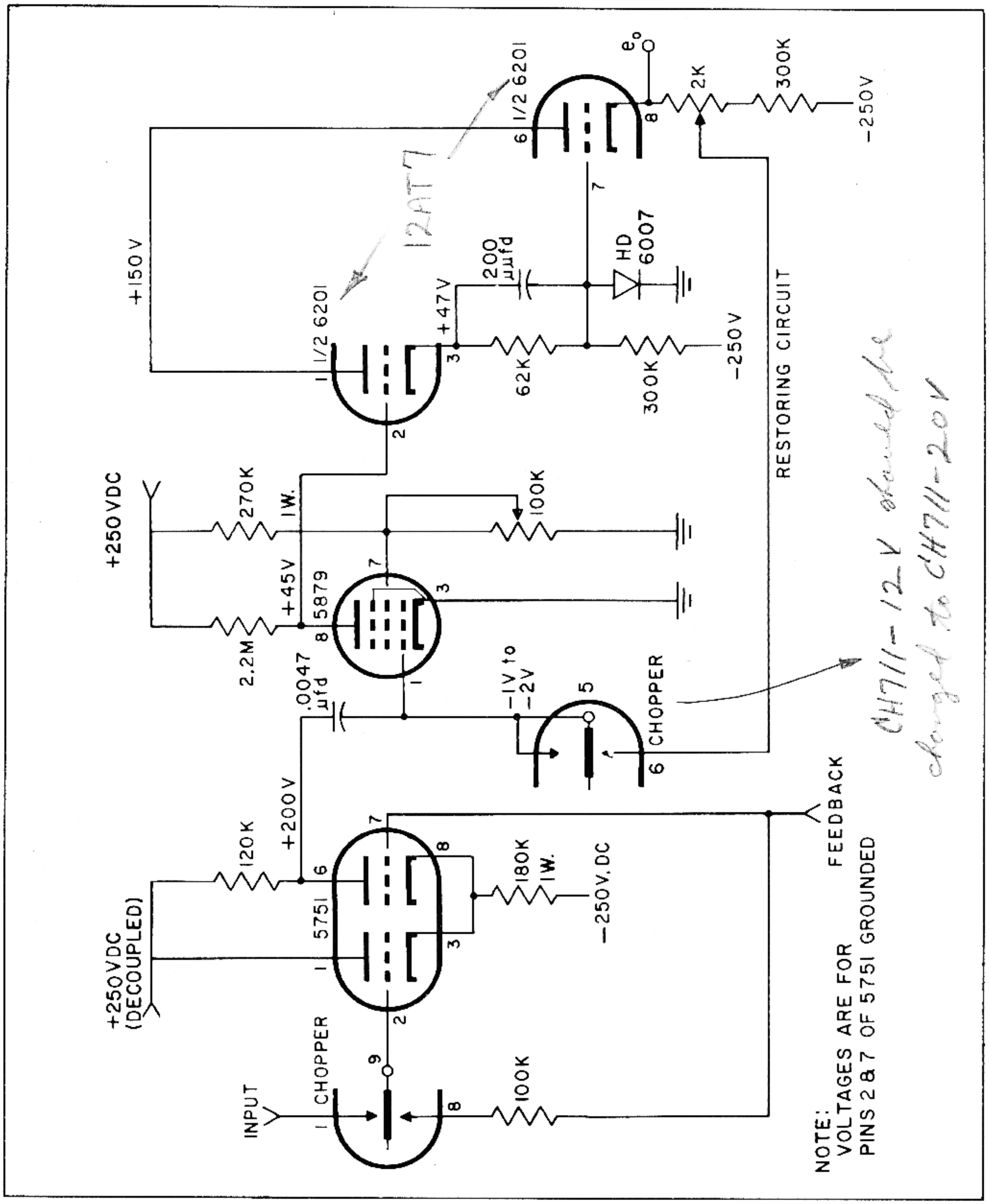


FIGURE 3-1. GENERAL BLOCK DIAGRAM



CH711-12V should be changed to CH711-20V

FIGURE 3-2. AMPLIFIER SCHEMATIC

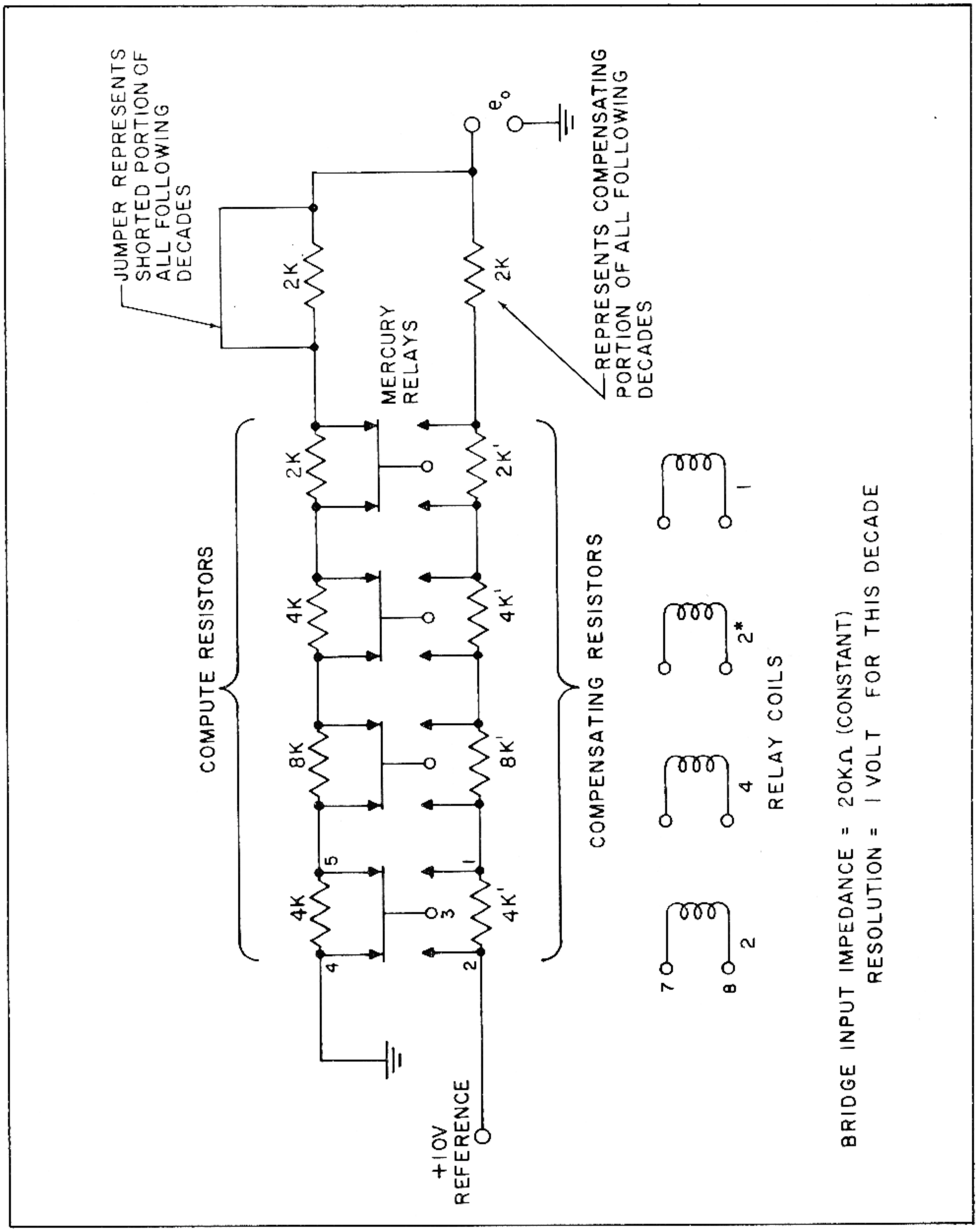


FIGURE 3-3. SCHEMATIC - WOLFF POGGENDORF BINARY OPERATED BRIDGE - MOST SIGNIFICANT DECADE

Potentiometers are provided to adjust the operating point of the 5879 near the zero grid current region. The amplifier has a voltage gain of approximately 5000 with an input impedance of 1000 megohms at null and an output impedance of 1000 ohms.

BRIDGE:

The type of bridge used in the Model M-24 is known as a Wolff-Poggendorf bridge. It can be simply defined as a potentiometer with relay or contact pickoff so designed as to allow a wide range of resolution. A standard resistor attenuator, in order to have 1 m.v. resolution over a range of 10 volts, would have to have 10,000 taps. However, a Wolff-Poggendorf decimal operated bridge would need only ten contacts per decade or a maximum of 40. To further simplify the number of contacts used, the Model M-24 operates the bridge according to a 242*1 binary code.

This minimizes the number of contacts to 4 per decade or a total of 16. A one-decade schematic of the bridge is shown in Figure 3-3. Reference to the coding chart (Figure 3-4) will assist the reader in understanding the code. By proper arrangement of relay actuation, any voltage ratio from .0001 to .9999 can be obtained from the bridge using only 16 relays.

ARABIC NUMERAL	BINARY NUMERAL 2	4	2*	1
0	0	0	0	0
1	0	0	0	1
2	1	0	0	0
3	1	0	0	1
4	1	0	1	0
5	1	0	1	1
6	1	1	0	0
7	1	1	0	1
8	1	1	1	0
9	1	1	1	1

CODING CHART

FIGURE 3-4

REFERENCE SOURCE:

The reference source consists of a matched pair of zener diodes encased in a Bulova oven for temperature stabilization. The first stage of regulation consists of a transistor constant current source. The second stage consists of the zener diodes connected as one branch of a Wheatsone bridge. The output of the bridge is taken as the reference voltage. For setting up and calibrating the reference source see Section V "CHECKING PROCEDURE".

POWER SUPPLIES:

The Model M-24 utilizes two regulated power supplies.

The low voltage power supply is a transistorized, series regulated supply. The Outputs are:

1. -27.5 VDC ±1% Ripple less than 20 m.v. of 120 cps and 200 m.v. of 768 cps (multivibrator frequency). This supply powers the entire logic system plus all of the relays in the Model M-24 and, in some cases, in the Series 20 accessories. Available current = 3 amperes. The filament voltage for the amplifier is also from this supply.

2. +33 VDC Ripple less than 1 V. at 120 cps. Available current is approximately 150 m.a. This supply is used only as bias for the logic transistor circuits.

The high voltage supply consists of a flux oscillator with three rectified outputs:

+250 VDC ±5% (across C-2)

+150 VDC ±5% (across C-1)

-250 VDC ±5% (across C-5)

The oscillator obtains its power from the -27.5 VDC and, because the low voltage is regulated, no regulation is required at the high voltage outputs.

The output voltages given in this paragraph are only across the capacitors C-1, C-2, and C-5 as shown in Dwg. No. 10050-035 sheet 2.

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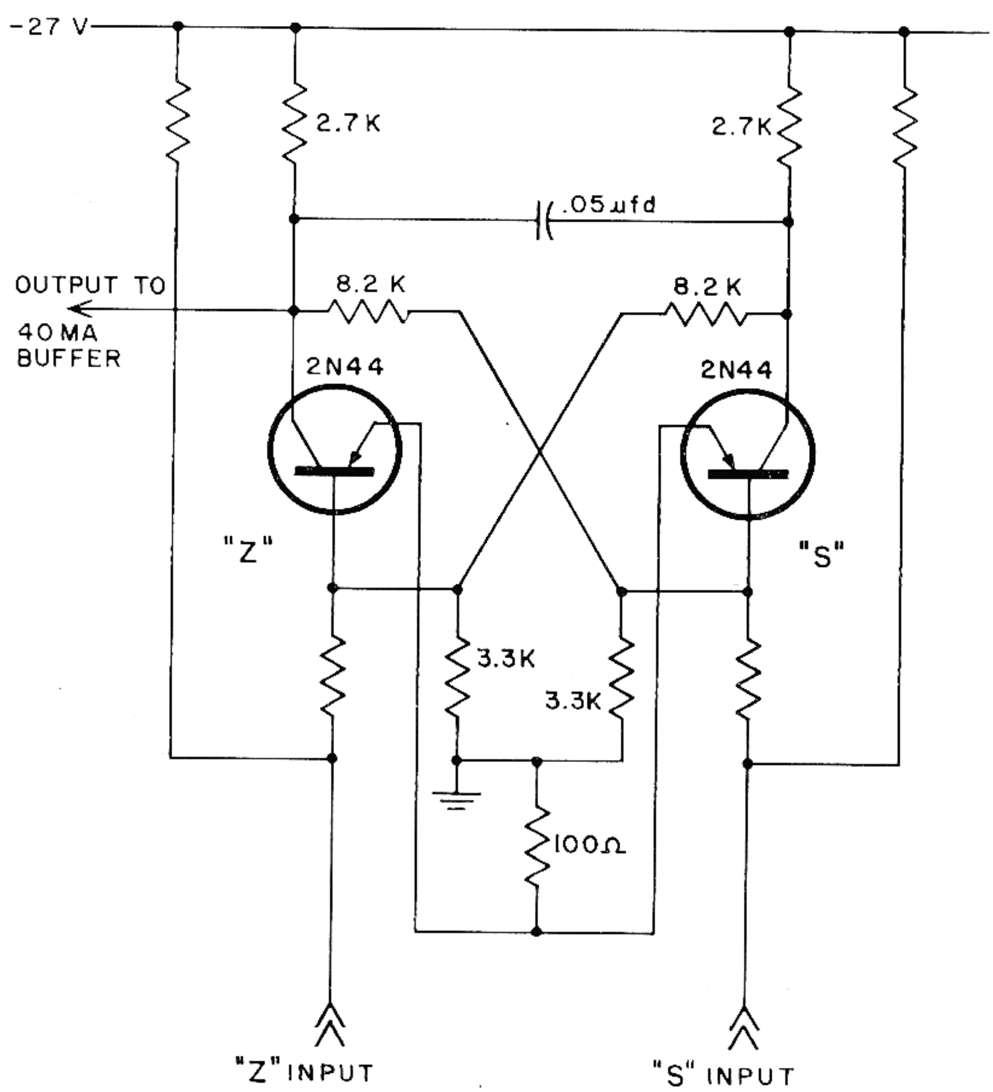

FIGURE 3-5. COMPUTE FLIP FLOP DESIGNED TO DRIVE A 40MA RELAY BUFFER

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Ripple content should be measured at the following points:

Pin 1 of V-3	Ripple less than 1 m.v.
Pin 1 of V-5	Ripple less than 100 m.v.
Junction of R 10 & R12	Ripple less than 1 m.v.

TYPICAL CIRCUIT DESCRIPTION:

The circuitry of the "A" unit consists largely of Transistor Flip-Flops, Diode Coincidence Circuits and transistor Power Amplifiers. Hereafter, the nomenclature of the various circuits will be as follows:

1. Flip-Flop will be referred to with the abbreviation "FF".
2. Diode Circuits will be referred to as either "AND" or "OR" Circuits.
3. Transistor Power Amplifiters will be referred to as Buffers.

All diodes used, with the exception of those in the Power Supply, are IN34A or LD125 Germanium Diodes.

FLIP-FLOP:

The FF's used in the Logic Circuit are, in all cases, bi-stable or binary. They are not designed particularly for speed, but more for positive operation and temperature compensation. These FF's will operate reliably up to 135°F. In some cases (particularly in the compute FF), a capacitor is connected across the collectors to slow down the operation. A typical FF Circuit can be seen in Figure 3-5, and the resistor values shown are those of a compute FF. The resistor values of the circuit may change for a FF designed for different use but the theory of operation is the same over-all. The bases of the FF transistors are marked with an "S" or a "Z" designating the SET input or the ZERO input. In all cases, except the counter, negative going pulses are applied to actuate the FF. For example: If the FF is to be turned on, a negative pulse is applied to the "S" base which causes that FF to set.

AND-OR CIRCUITS:

The "AND" and "OR" Circuits used are standard diode coincidence circuits and a typical example of each can be seen in Figure 3-6.

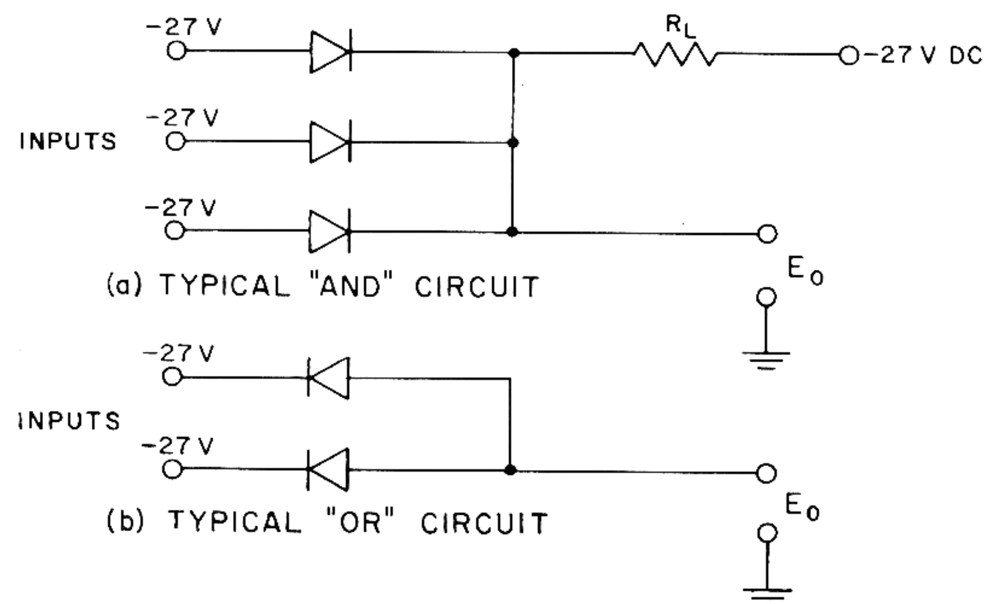

FIGURE 3-6. TYPICAL "AND" "OR" CIRCUIT

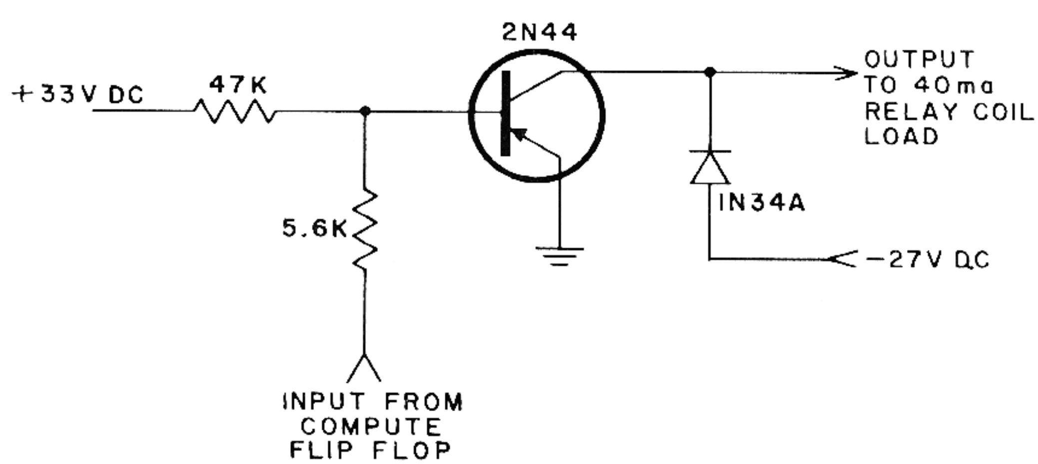

FIGURE 3-7. TYPICAL 40MA BUFFER

BUFFER:

Most buffers consist of one transistor used as a simple ground emitter current amplifier. The buffers are positively biased by +33 VDC taken from the Low Voltage Power Supply. This is to insure minimum cut-off current through the buffer load which is usually a relay or a readout bulb. Typical buffer circuit can be seen from Figure 3-7, and resistor values shown are for a 40 ma buffer.

"A" UNIT PRINTED CIRCUIT BOARDS:

All of the compute logic of the Model M-24 is contained on removable printed circuit boards found in the "A" Unit. They are classified as follows:

1. Five-Stage Counter Board (Quantity One) which consists of:
    a. An FF operated gate
    b. A Phase Inverter
    c. A Five-Stage Counter
    d. An Output or Logic Matrix with 25 Outputs

2. A Three-Stage Counter Board (Quantity One) which contains:
    a. Multi-Vibrator
    b. A Three-Stage Counter
    c. A Timing Matrix
    d. Two Transistorized Schmitt Triggers
    e. A Decision Matrix and a Decision FF
    f. A two Transistor Buffer to power the First Compute Relay in the Bridge
    g. Chopper Drive

3. A Range and Polarity Board (Quantity One) which consists of:
    a. Range and Polarity Compute FF's
    b. Range and Polarity Storage FF's
    c. Range Decoding Matrix
    d. Range and Polarity Readout Buffers
    e. Range and Polarity Compute Buffers

4. Decade Board (Quantity Four) which consists of:
    a. Binary Compute FF's
    b. Compute Buffers
    c. Binary Storage FF's

d. Binary to Decimal Decoding Matrix
e. Buffers (Quantity Ten) to drive the readout bulbs

Physical location of the boards can be found on Figure 5-3. The "A" Unit also contains the bridge resistors and relays (see Figure 5-3) and the readout.

TIMING CIRCUITS:

The heart of the Model M-24 Logic is a transistorized multivibrator that operates at 768 cps ±5%. All of the timing throughout the entire instrument is derived from this multivibrator. The multivibrator is coupled to the input of a three-stage counter. The three-stage counter operates as an ordinary binary counter which counts input pulse from 0 through 7. By means of a timing matrix, consisting of "AND" circuits, five of the possible eight sequential outputs are taken. (See Figure 3-8)

The Output of the last stage of the three-stage counter is coupled through a gate to the input of the first stage of the five-stage counter. The five-stage counter is also a binary counter which counts input pulses from 0 through 31. (See Figure 3-9)

SCANNING OPERATION:

During the scanning period, the logic circuits are automatically operating the bridge so that the feedback voltage is periodically increasing in precise increments. As long as the magnitude of the feedback voltage is less than the input voltage, the polarity of the amplifier output is such that the amplifier has no effect on the operation of the bridge. However, following an incremental change of feedback voltage which causes the feedback voltage to exceed the input voltage, the polarity of the amplifier reverses and a decision pulse is fed into the logic circuits. The logic circuitry upon receipt of a decision pulse forces the bridge back to the previous output voltage. Thus, the amplifier and logic reject all feedback increments which make the feedback exceed the input; and the feedback at the end of scan is the summation of all feedback increments which have not been rejected.

The amplifier output is connected to the common input of two Schmitt triggers. These triggers are so designed that both inputs are at zero if the amplifier output is at null (restoring level). If the amplifier output goes more positive than the restored level, the " + Trigger" output will go negative (Test Point F, Figure 5-4) and if the amplifier output goes more negative than the restored level, the " - Trigger" output will go negative (Test Point E, Figure 5-4). The Trigger outputs connect to the Decision Matrix. Other inputs to the matrix come from the Polarity FF and the Scan FF. The output of the matrix feeds the "S" input of the Decision FF. Only one trigger is effective in setting the Decision FF at any given time, and which trigger is effective is determined by the matrix (See Figure 3-10).

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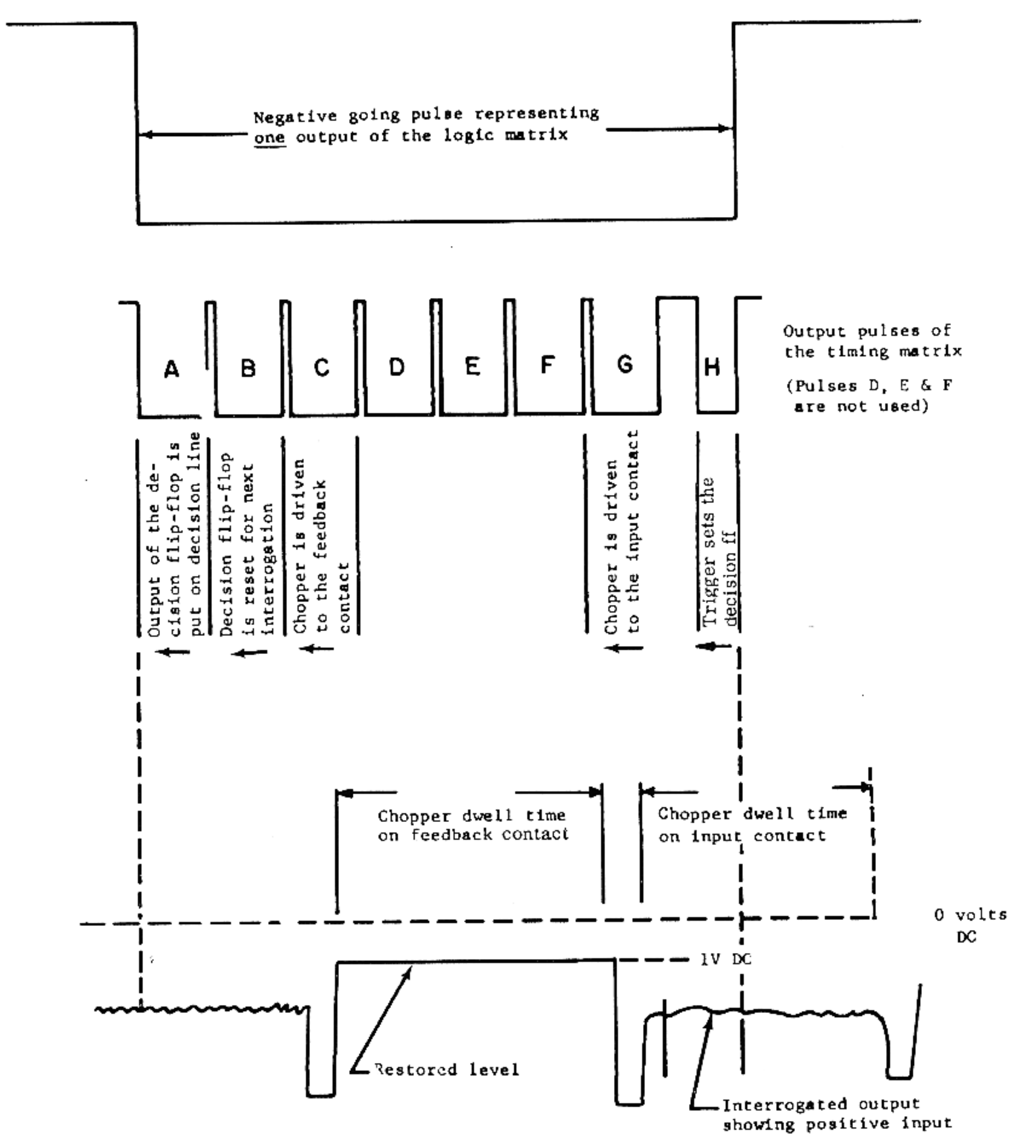

FIGURE 3-8. TIMING DIAGRAM

COUNTER STATE	COUNTER PIN NO.	PULSE FUNCTION SET	PULSE FUNCTION ZERO
0	-	Gate	
1	1	Range Relay A & C	
2	59		Bridge
3	2	Polarity (*), Scan	
4	3		C (on "RATIO" & "AC")
5	4	Range Pulses (*)	
6	-		
7	5		
8	-		
9	6	Decade 5 Comp. 2	Scan Relay
10	-		
11	7	Decade 5 Comp. 4	Decade 5 Comp. 2 (*)
12	-		
13	8	Decade 5 Comp. 2*	Decade 5 Comp. 4 (*)
14	-		
15	9	Decade 5 Comp. 1	Decade 5 Comp. 2* (*)
16	-		
17	10	Decade 4 Comp. 2	Decade 5 Comp. 1 (*)
18	11	Decade 4 Comp. 4	Decade 4 Comp. 2 (*)
19	12	Decade 4 Comp. 2*	Decade 4 Comp. 4 (*)
20	13	Decade 4 Comp. 1	Decade 4 Comp. 2* (*)
21	14	Decade 3 Comp. 2	Decade 4 Comp. 1 (*)
22	15	Decade 3 Comp. 4	Decade 3 Comp. 2 (*)
23	16	Decade 3 Comp. 2*	Decade 3 Comp. 4 (*)
24	17	Decade 3 Comp. 1	Decade 3 Comp. 2* (*)
25	18	Decade 2 Comp. 2	Decade 3 Comp. 1 (*)
26	19	Decade 2 Comp. 4	Decade 2 Comp. 2 (*)
27	20	Decade 2 Comp. 2*	Decade 2 Comp. 4 (*)
28	21	Decade 2 Comp. 1	Decade 2 Comp. 2* (*)
29	57		(Readout) Decade 2 Comp. 1 (*)
30	58	Readout	
31	26	Print Pulse	

NOTE: THE SYMBOL (*) DENOTES THAT THE PULSE PERFORMS THE DESCRIBED FUNCTION ONLY WHEN IT IS COINCIDENT WITH A DECISION PULSE.

PULSE LEGEND

FIGURE 3-9

The incremental voltage changes of the bridge output are dependent upon the particular decade that is being scanned. For instance, if the decade being scanned is the most significant decade, the output of the bridge would be in 100 millivolt increments; the second decade would be in 10 m.v. increments and so on to 0.1 m.v. increments in the least significant decade.

After the decades have been scanned and the proper decisions have been made, the position of the bridge is stored in the readout memory circuits and the memory circuits transfer this information to the readout in decimal form.

The scanning sequence of the Model M-24 is controlled by the output pulses of the logic matrix. Each operation of the instrument occurs at a definite period of time determined by the particular logic pulse that controls it. For instance, Pulse #6 sets the 2 compute FF of the 5th decade and Pulse #7 zeros that same FF with a decision. The output of the bridge, therefore, will always increase by a factor of 20% of the Reference Voltage at that time.

If that voltage exceeds the input, a decision will be made at Time "H" when the pulse on Pin #6 of the five stage-counter appears (refer to Figure 3-8 TIMING DIAGRAM) and at Time "A" of the pulse on Pin #7 of the five-stage counter, the 2 compute FF will be zeroed.

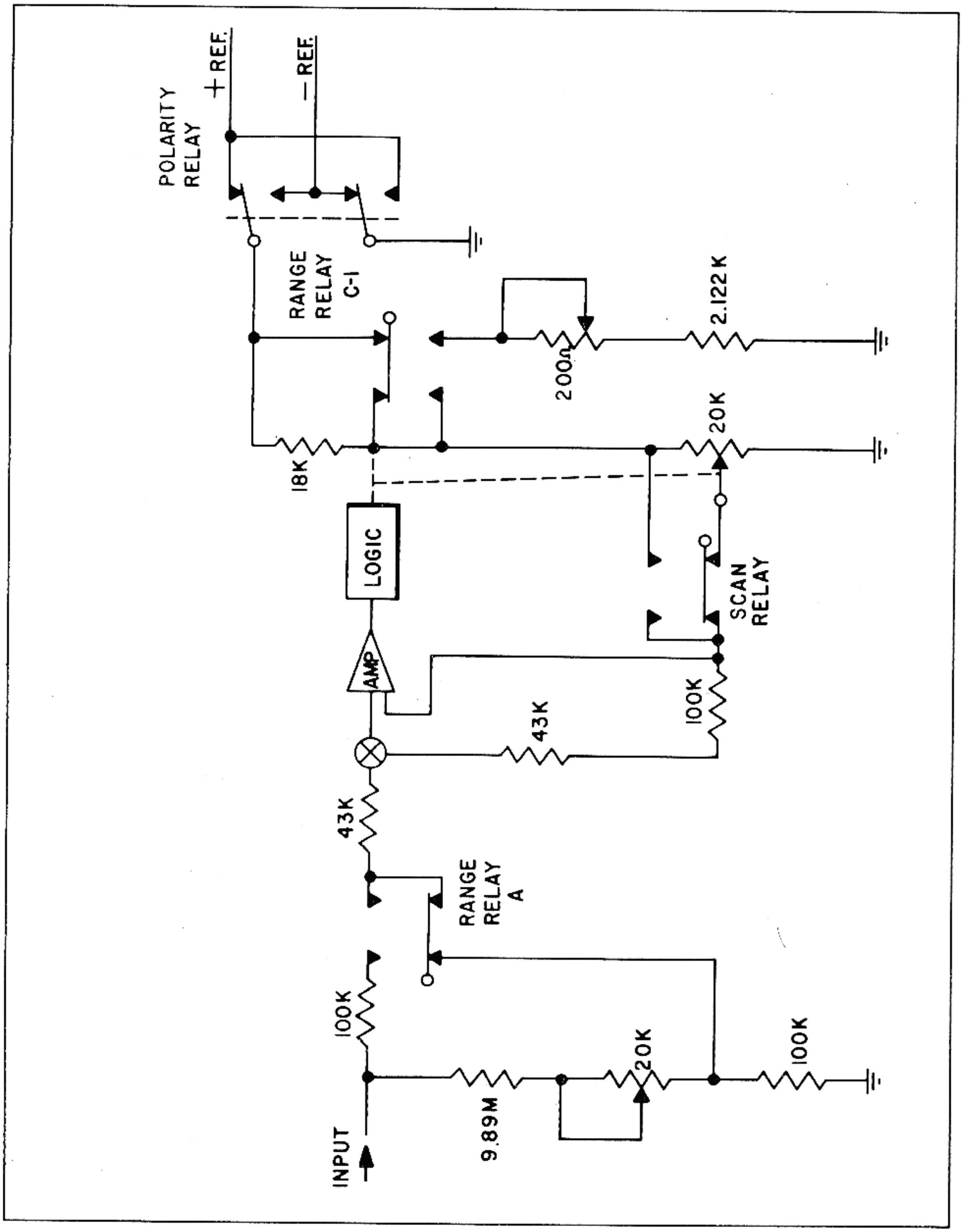

FIGURE 3-11. SIMPLIFIED SCHEMATIC SHOWING RANGE AND POLARITY RELAY CONNECTIONS FOR VOLTS DC FUNCTION

Each compute bit, or FF, is operated similarly throughout the computing region of the scan, including the polarity and range selection. At the end of the pulse on Pin #21 of the five-stage counter the last decision will be made and all following operations are performed without decision.

After the compute part of the scan (counter state #28), all of the information with regard to bridge position is contained in the compute FF's. Also, all information with regard to the old reading (the one previous to the current scan) is contained in the readout storage FF's.

The pulse on Pin #57 of the five-stage counter zeros all readout storage FF's. The pulse on Pin #58 of the five-stage counter provides power to outputs of the compute FF's and upon the advent of this pulse, all "SET" compute FF's will "Set" their readout storage counterparts. The decoding matrix extracts the proper decimal sum from the binary make up of the storage FF's and transmits this information through a readout buffer to the proper bulb in the readout. At the time of the pulse on Pin #59 of the five-stage counter during the next scan, all of the compute FF's will be reset and new computation has begun. The readout storage FF's, however, will retain their state until the pulse appears on Pin #57 of the five-stage counter which will again reset the readout.

Amplifier Output	+ Trigger Output	- Trigger Output	Polarity F-F	Scan F-F	Decision Pulse	Relay
+	-		+	Polarity	-	Reject
Null	0		+	&	0	Hold
-	0		+	Digits	0	Hold
+		0	-		0	Hold
Null		0	-		0	Hold
-		-	-		-	Reject
+		0	+		0	Hold
Null		0	+		0	Hold
-		-	+	Range	-	Reject
+	-		-		-	Reject
Null	0		-		0	Hold
-	0		-		0	Hold

DECISION LOGIC

FIGURE 3-10

RANGE AND POLARITY OPERATION

Range and polarity are automatically selected in the Model M-24. The method of selection is similar to the method of proper bridge output selection. This section describes the range and polarity relay functions. Refer to Figure 3-11.

POLARITY RELAY

The functions performed by the polarity relays are:

1. To select proper reference voltage polarity to make the voltage computation.

   This function is performed by means of one of two "dry" relays found in the "B" unit. One relay is used to select the internal reference polarity for VDC operation and the other selects external reference polarity for Ratiometer operation. The method of operation for each relay is the same. However, the proper relay to be operated is controlled by the "Function" switch. Dry relays are used here because of the "make-before-break" characteristic of mercury wetted relays. However, in order to obtain maximum life expectancy of the dry relays, they are treated as latching devices and operate only when the input polarity is changed.

RANGE RELAYS:

Referring to Figure 3-11, each relay function is described as follows:

1. Range Relay "A" controls the unknown input to the amplifier by connecting it either directly to the amplifier or by attenuating it by a factor of 100.

2. Range Relay "C1" controls the reference voltage applied to the bridge.

3. Range Relay "C2" controls the standard resistor size when measuring K

Figure 3-12 is a chart showing relay function for all ranges:

RANGE	RELAYS A	RELAYS C	INPUT	REFERENCE	BRIDGE RESOLUTION
0 - .9999 v.	x	x	Direct	1 v.	100 microvolts
1 - 9.999 v.	x		Direct	10 v.	1 millivolt
10 - 99.99 v.		x	1/100	1 v.	100 microvolts
100 - 999.9 v.			1/100	10 v.	1 millivolt

FIGURE 3-12

Range switching of the "Ohms" function is also automatic and controlled by the same relays except Relay C1 is substituted for Relay C2. In Ohms function, the input to the amplifier is one leg of a Wheatstone bridge. A re-arrangement of Figure 3-11 would be:

RANGE	RELAYS A	RELAYS C	INPUT
0 - .9999K	x	x	$\frac{Rx}{Rx + 1K\,\Omega}$ x 15 V.
1K - 9.999 K	x		$\frac{Rx}{Rx + 10K\,\Omega}$ x 15 V.
10K - 99.99 K		x	$\frac{Rx}{Rx + 100K\,\Omega}$ x 15 V.
100K - 999.9 K			$\frac{Rx}{Rx + 1\ \text{Meg.}}$ x 15 V.

SCAN RELAY:

Also found in the range circuits is a "Scan FF" which drives a "Scan" relay.

The function of this relay is to switch the feedback from the output of the bridge to the existing bridge reference voltage. This is done while determining range so that the amplifier can decide if the input is of a greater magnitude than the available reference.

The Scan Flip-Flop also provides intelligence to the decision matrix so that the output of the proper trigger ("+" or "-" trigger) will be used in making decisions. In determining range, a decision is required if the input is greater than the feedback which is opposite the condition required while computing the magnitude of the voltage.

FUNCTION SWITCHING

The methods and theories of operation described in this manual apply to the operation as a DC voltmeter. Basically, the meter operates as such in all functions. However, this portion will describe the basic difference of the various functions.

RATIO FUNCTION:

1. Range is automatically set to the normal 1-10 v. range at the beginning of each scan.

2. The bridge reference voltage is switched from the internal source to the pins of the External Reference Connector. External reference ranging from $\pm$ 1 V.D.C. to $\pm$100 VDC must then be applied for operation. Note that the magnitude of the "+" reference voltage need not be the same as that of the "-" reference in order for the Model M-24 to operate. Satisfactory results will be obtained in both polarities as long as each reference is within 1 to 100 VDC. However, if the ratiometer is to read the output of a bridge or transducer connected only to "+" and "-" reference with no ground connection, then the ratio on the readout will be a function of the ratio of the "+" reference to the "-" reference and of the actual transducer output ratio. In this case, it is advisable to use identical reference voltages.

3. The input circuitry of the Model M-24 is disconnected from signal ground and the input impedance becomes 1000 megohms.

OHMS FUNCTION:

1. The input attenuator is disconnected from signal ground.

2. Calibrated standard resistors are connected to the proper input range relay contacts.

3. The top portion of the bridge or "Compensating Resistors" are substituted for a calibrated 20K Ω resistor.

4. The "Reference" voltage to the Scan relay is substituted for the output of a 2:1 divider thereby retaining the normal range function of the Scan relay.

VDC FUNCTION:

Connects all circuitry as described in Figure 3-11.

VAC FUNCTION:

1. Automatically locks the Model M-24 in the 1-10 V range. All range selections of AC voltages are manually controlled by the Model M-24 front panel controls. However, AC voltages are fed into an AC to DC converter and range control is directed to that unit. All outputs of the AC-DC converter are less than 10 VDC if the proper range has been manually selected.

2. All other connections remain the same as VDC operation.

SECTION IV - CALIBRATION PROCEDURE

EQUIPMENT REQUIRED:

1. Standard Voltage Source: Any accurate voltage source to ±.01% or better. The input impedance of the Model M-24 (10 megs ±0.05%) must be considered to determine calibration point. Non-Linear Systems, Inc. utilizes 9 Eppley standard cells with a calibration voltage of 9.167 V.D.C.

2. Precision 10:1 resistive divider calibrated for a 10 Meg. load.

   Figure 4-1 shows resistor values which can be used in the precision divider.

PROCEDURE:

1. Turn on the Model M-24 as per directions given in Section II and allow a 30 minute warm-up period. It is best to set the MODE switch to Standby and have the input leads shorted. Turn to Continuous Scan after warm-up.

2. Set the FUNCTION switch to V.D.C.

3. Connect the input leads to the Standard Voltage Source. Reading should be that voltage previously determined for the output of the Standard source ±1 digit. If not, correct the reading by means of the "1-10V." adjustment potentiometer (see Figure 5-8).

4. Connect the 10:1 divider to approximately 9 V.D.C. and the Model M-24 input leads to the direct output (E) of the divider. Note the reading of the M-24.

5. Connect the input leads to the E/10 terminal. The new reading should be 0.1 times the reading of Step #4 ±2 digits. If not, adjust the 0-1 volt screwdriver adjustment (see Figure 5-8) for the correct reading.

6. Connect the 10:1 divider to a 90 VDC source. Connect the input leads of the M-24 to the E/10 terminal and note the reading.

7. Connect the input leads to the direct (E) output of the divider. The reading should be ten times that of Step #6. If not, adjust the 10-100V. screwdriver adjustment (see Figure 5-8) for a correct reading.

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8. Repeat Steps #4 through #7 to check all calibration. Check each voltage on both polarities by means of the reversing switch (Figure 4-1) and check the offset. The polarity offset should not be more than ± 2 digits. If the offset is excessive, check the amplifier output level (Section V and Figure 5-1).

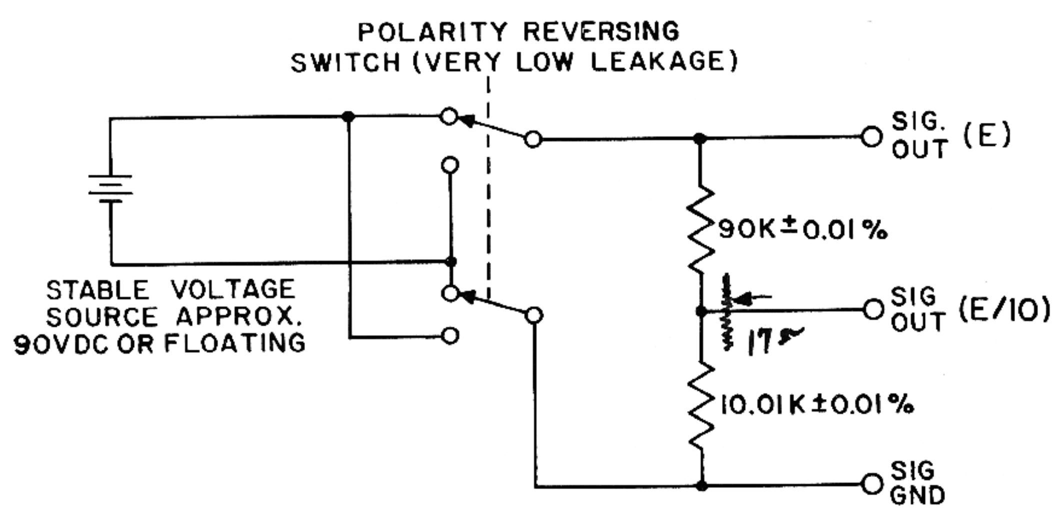

FIGURE 4-1. CALIBRATION DIVIDER

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SECTION V - MAINTENANCE AND TROUBLE SHOOTING

GENERAL:

As in most digital instruments, a malfunction of the Model M-24 can usually be detected by a visual observation of the readout. The following paragraphs will attempt to pinpoint the faulty section or circuits by a routine checking method.

EQUIPMENT REQUIRED:

1. Oscilloscope with:
   a. Calibrated sweep
   b. Calibrated DC Vertical Amplifier
   c. External trigger input
2. Volt-Ohm-Milliameter
3. VTVM
4. Reference Voltage source (+ and - 1.3 V $\pm$.1 VDC); a mercury cell will be very satisfactory.
5. Variable input source with 0.1 m.v. resolution
6. Calibrated variable divider with 4 calibrated decades

   It is also suggested that a quantity of recommended spare parts be available.

   During trouble shooting the operator must never tilt either unit greater than $\pm 30°$ with the power on or the external reference connected.

TROUBLE SHOOTING

Problems may arise where only the readout itself is incorrect. Check the following descriptions and make the necessary repairs before proceeding further.

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READOUT FAILS TO ILLUMINATE:

1. Most probable cause is loss of - 27.5 VDC. Check the power fuses and measure the output of the low voltage power supply.

2. Faulty common contact. Remove the readout and adjust.

ONE DIGIT FAILS TO LIGHT:

1. Faulty bulb or contact. Remove the readout and correct.

2. Bad lamp buffer in the decade board corresponding to faulty readout decade.

ONE DIGIT LIGHTS CONSTANTLY (even though it is incorrect):

1. Faulty lamp buffer in the decade board.

DOUBLE DIGIT ILLUMINATION (for particular readings):

1. Faulty diode in the decoding matrix of the decade board.

REMOVING THE READOUT:

Turn the Power switch to OFF (important precaution)

Slide the visor up as far as possible and pull out (do not force). Spread two side clamps holding the Readout, and allow the Readout to swing forward. Remove Readout. To install, hold Readout horizontal. Engage the two screw heads (pivot points) with the notches in the clamps. Rotate the Readout up into position until locked.

Replace the visor.

COMPLETELY ERRONEOUS READING OF THE READOUT:

In this case, the problem could lie in the:

a. Reference source.

b. Amplifier - including high voltage power supplies.

c. Logic circuits - including the low voltage power supplies. To determine computation errors, check the instrument according to the calibration

procedures in all functions. Do not attempt to re-calibrate the instrument if it is obvious that the Model M-24 is not working properly.

CHECKING PROCEDURE

REFERENCE VOLTAGE SOURCE AND AMPLIFIER

1. While checking the instrument in all functions, determine if the malfunction exists only in the volts functions. If so, it is likely that the reference source is at fault, as Ratio and Ohms each have separate reference sources.

2. The output of the reference source appears between Pins 1 & 8 of K-5 (see Dwg. No. 10050-035). The voltage measured here should be 12 $\pm$0.1 VDC. (Use a 20 KΩ/v multimeter for this measurement.) The ripple should be less than 200 uv peak-to-peak. If the reference source meets these two tests, proceed no further. Do not touch R-35 and R-39. These two potentiometers are factory adjusted and no readjustment will be needed unless some component in the reference source fails. If a failure occurs, then the reference source should be recalibrated as follows:

   a. Put function switch on DC volts.

   b. Short the input leads and scan the meter once. The reading must be + or - .0000 DC before proceeding further.

   c. Adjust R-39 so that the voltage drop across R-37 is 12 VDC. (Use a 20 KΩ/v multimeter)

   d. Connect a 5 uf condenser from the positive terminal of C-16 to the collector of Q-1.

   e. Adjust R-35 until the output voltage of the reference source has less than 200 uv peak-to-peak ripple.

   f. Disconnect the 5 uf condenser.

   g. Connect the input leads of the meter to a known voltage in the 1-10 V. range and adjust R-17 until the meter is reading properly. (If the zener diodes, CR-16, have been replaced, - replace them only with another matched set P/N 020359A-HOFFMAN - it may be necessary to short or unshort some combination of R-14, R-15, and R-16 to bring R-17 in the right range.)

   h. Repeat steps a. through f.

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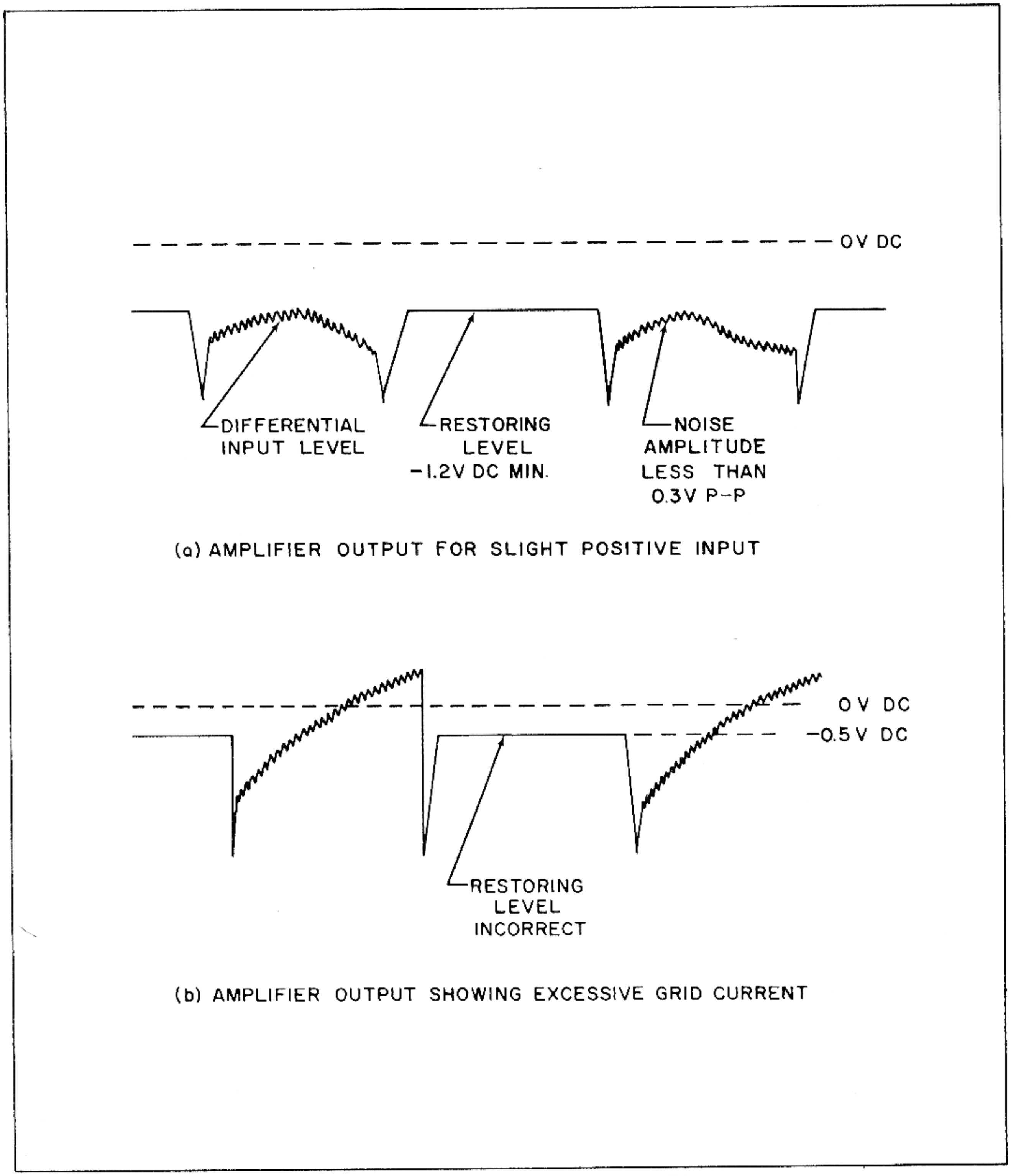

FIGURE 5-1. AMPLIFIER OUTPUT

3. If the error exists in all functions, operate the instrument on Ratio function according to the Operation Instructions (SECTION II) with a reference voltage of + and - 1.3 V $\pm$ .1 VDC, and scan the meter ONCE with shorted input leads.

4. Connect an oscilloscope to the output of the amplifier and observe the wave form. The amplifier output should appear as shown in Figure 5-1 a.

5. If the amplifier output is saturated, scan the meter once more with an input ratio of approximately $\pm$ .0555 and adjust the input divider until the amplifier output is similar to Figure 5-1 a or 5-1 b.

6. If the output looks like 5-1 b, adjust the amplifier as follows:

   a. Set the output potentiometer (R-11 Dwg. No. 10050-035) fully counterclockwise.

   b. Adjust the 100K Potentiometer (R-8) clockwise until the output looks like Figure 5-1 a. If this cannot be obtained, change the 5879 pentode.

   c. When the amplifier output has been adjusted satisfactorily, check the output level according to Step #18.

7. If the amplifier output is similar to 5-1 "a" but is erratic or has excessive noise, change the chopper and recheck the output. (Chopper should be factory adjusted to NLS requirements.)

8. Check the high voltage power supply according to SECTION IV Required Outputs.

9. Set the divider to 5000 and try to obtain a reading of approximately +5000 $\pm$ 1000. Set Mode switch to Standby.

10. Readjust the divider, if necessary, for a balanced output of the amplifier. The output is balanced when the differential input level (Figure 5-1 a) is $\pm$ 0.5V of the restored level.

11. Amplifier output should again appear as in Figure 5-1 a.

12. Connect the oscilloscope to the output of the "+" trigger (Test Point "F", Figure 5-4).

    NOTE: Because of the fact that the test points on the logic boards are sometimes inaccessible while the board is mounted in the "A" unit, it is advisable to obtain a set of Test Extension Boards from NLS.

13. The output of the "+" trigger should be -1.5V $\pm$1 VDC. If so, follow Step #14. If the trigger output is -25V $\pm$2 VDC, then decrease the input divider by one digit. The trigger output should drop to -1.5 VDC before the one digit change is complete.

14. Increase the divider reading by two digits. The trigger output should go to -25 $\pm$2 VDC before a two digit change is completed on the divider.

15. Reverse polarity on the input to the divider and try to obtain a reading of approximately -5000 $\pm$1000. Set Mode switch to Standby.

16. Repeat Steps #10 and #11.

17. Connect the scope to the "-" trigger output (Test Point "E", Figure 5-4) and repeat Steps #13 and #14.

18. In case the amplifier output level is suspected or a new tube has been put in the amplifier, the following procedure should be used to check the amplifier output level.

    a. Connect a voltmeter or a scope beam to each trigger output (Test Points "E" and "F", Figure 5-4)

    b. Obtain a $\pm$.0000 readout reading (regardless of input voltage required) and put the instrument on Standby.

    c. Short the input leads together and connect them to chassis ground.

    d. Determine that the amplifier output shows a nulled condition.

    e. If both trigger outputs are reading -1.5 VDC $\pm$1 VDC, then the amplifier output level is O.K.

    f. If the output at Test Point "E" is -25 V $\pm$2 VDC, then adjust R-11 clockwise until it goes to -1.5 V.

    g. If Test Point "F" is -25 V $\pm$2 VDC, then adjust R-8 clockwise (IMPORTANT: Do not turn R-8 counterclockwise past the point determined for zero grid current) until it goes to -1.5 V $\pm$1 VDC.

19. Connect the scope to the decision line. (Pin 851 of the three-stage counter board.

20. Set the input divider to ±5000 and scan the meter once, then go to Standby.

21. There should be no decision pulses or if there are some, they should be very erratic in frequency.

22. A one digit change of the divider should be all that is needed to change the decision line from a condition of no pulses to a condition of one every 10 milliseconds and vice versa.

23. Repeat Steps #21 and #22 for both input voltage polarities.

24. If everything checks out O. K. in Steps #4 through #18 but Steps #20 through #23 are not all right, then the malfunction is in either the decision matrix or the decision FF.

25. To determine if the correct input voltages are at the decision matrix, measure the voltage at Pins 850, 852, 854, and 855 as follows:

INPUT POLARITY	VOLTAGE PIN NUMBERS			
	850	852	854	855
+	- 2V	-15V	-15V	-2V
-	-15V	- 2V	-15V	-2V

All voltages on this table are approximate and the attention should be given to the relationship of 850 to 852, and of 854 to 855 rather than the precise magnitude of the voltage.

LOGIC CIRCUITS:

26. Set the variable divider to ±.0001 and scan the meter once. Readout should read +.0001. If any positive number other than +.0001 appears, exchange the decade board corresponding to the most significant digit other than zero for a spare or for the decade 2 board. Repeat Step #26.

27. If the error still appears, exchange the compute relays in the "A" Unit corresponding to the most significant decade in error. Repeat Step #26.

28. If the error still persists, the trouble is most likely in the 5-stage counter. See Step #32.

29. Advance each decade, starting with the least significant decade of the divider through all digits 0 through 9 while the meter is scanning continuously. Return each decade to Zero after the digit 9 has been checked.

30. Observe the reading as the divider is advanced and note which decade gives the first indication of error. For example, all numbers +.0000 through +.0200 compute properly but number +.0300 on the divider reads out +.0289.

31. Exchange that decade board and/or the decade relays to determine the faulty component.

32. If Steps #29 through #31 fail to reveal a faulty decade board or compute relay (this can be determined if the error persists in one decade even though relays and boards have been exchanged), plug the 5-stage counter extension board in and proceed to test the 5-stage counter board.

33. Set the meter to continuous scan and connect the external trigger of the scope to Test Point "G" (see Figure 5-6) of the five-stage counter board.

34. Connect the scope input lead to each pin of the 31-pin connector starting with #1 through #21. Each pin should have one negative pulse (amplitude varies -5 to -15 VDC) with a 10.4 m.s. duration for each scan. If more than one pulse appears during the 330 m.s. scan on any pin, that pin is connected to a faulty "and" circuit. (Open diode.) If each pin does not have at least one pulse, the 5-stage counter is defective.

    The operator will notice that each pulse appears at a time following the pulse on the previous pin. These pulses are the logic pulses mentioned in Section III and examination of the pulse legend Figure 3-9 will show the operator which circuits will be affected by pulses appearing at the wrong time or not appearing at all.

    If a malfunction appears on any of the first six pins, then the range and polarity computation will be incorrect.

35. If range and/or polarity have been incorrect, check the Range and Polarity relays in the "B" unit. If this is not the cause, then exchange the Range and Polarity logic board with a spare.

36. With the oscilloscope still triggered by Test Point "G" of the Logic Matrix, connect the scope input to Pin #59. A negative pulse should appear corresponding to counter state #2. This is the compute reset pulse.

37. Set the divider to 0 in the most significant decade.

38. Connect the scope to Pin #58. A negative pulse corresponding to counter state #30 should appear.

39. Connect the scope to Pin #57. A negative pulse should appear corresponding to counter state #29.

40. Connect the scope to Pin #7 of the 3-stage counter board. A pulse going from -27 VDC quiescent to -.5 VDC for 10.4 m.s. should appear corresponding to that pulse appearing on Pin #6 of the 5-stage counter board.

41. Increase the divider to a number greater than +2000. Voltage at Pin #7 of the 3-stage counter will be -27 VDC from the start of the pulse on Pin #2 of 5-stage counter to the start of the pulse on Pin #6 of the 5-stage counter, then it will drop to -.5 VDC until the pulse on Pin #2 of the 5-stage counter appears again during the following scan.

METER FAILS TO SCAN PROPERLY, as follows:

a. Scans at double frequency

b. Fails to complete a scan when Mode switch is set to Single Scan

c. Fails to scan at all

42. Check the outputs of the logic matrix as given in Steps #33 through #39 as described above.

43. Set the Mode switch to standby. Connect the scope to the 5-stage counter output (Figure 5-6).

44. Operate the Single Scan Mode. The 5-stage counter output should complete one full cycle in 330 m.s.

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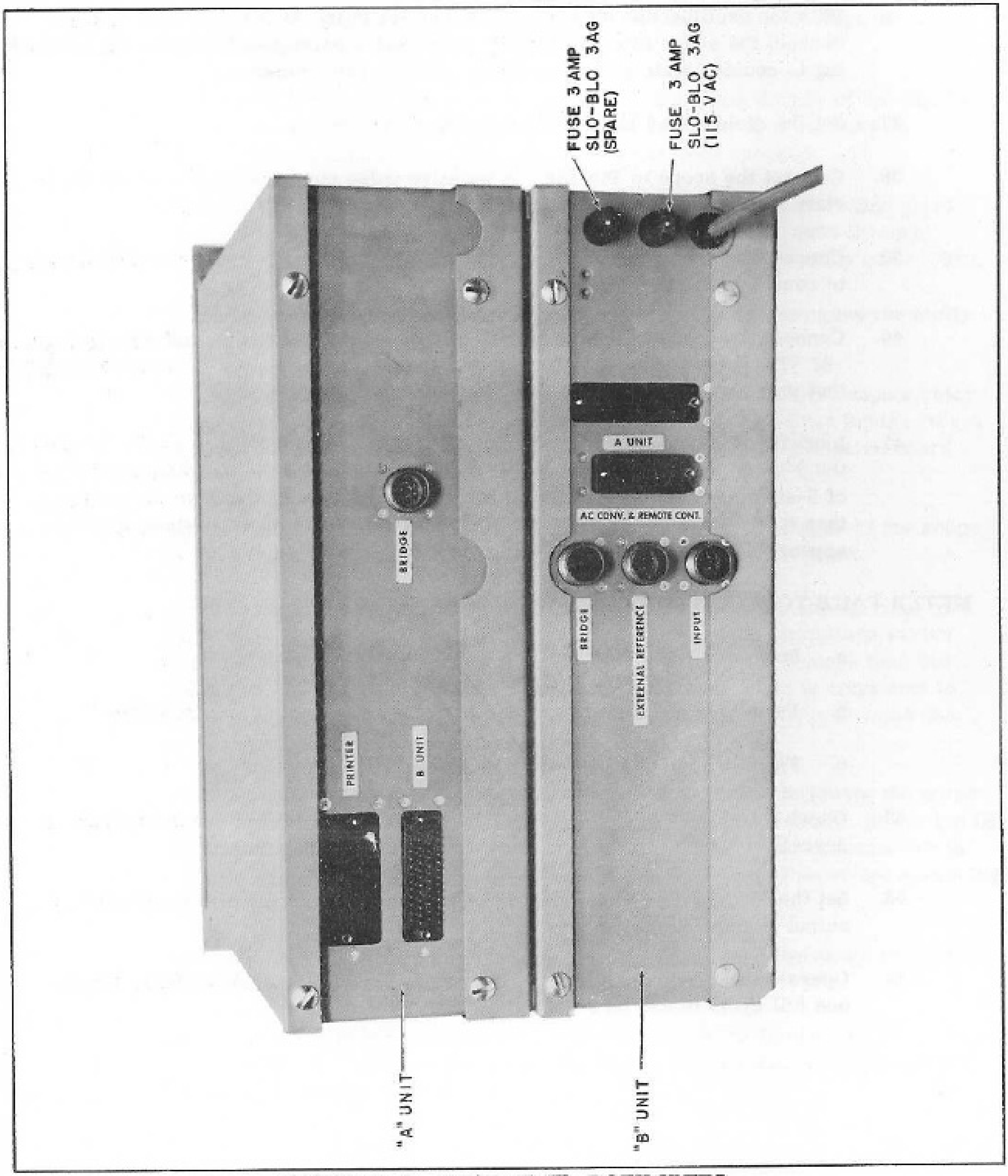


FIGURE 5-2. REAR VIEW, BOTH UNITS

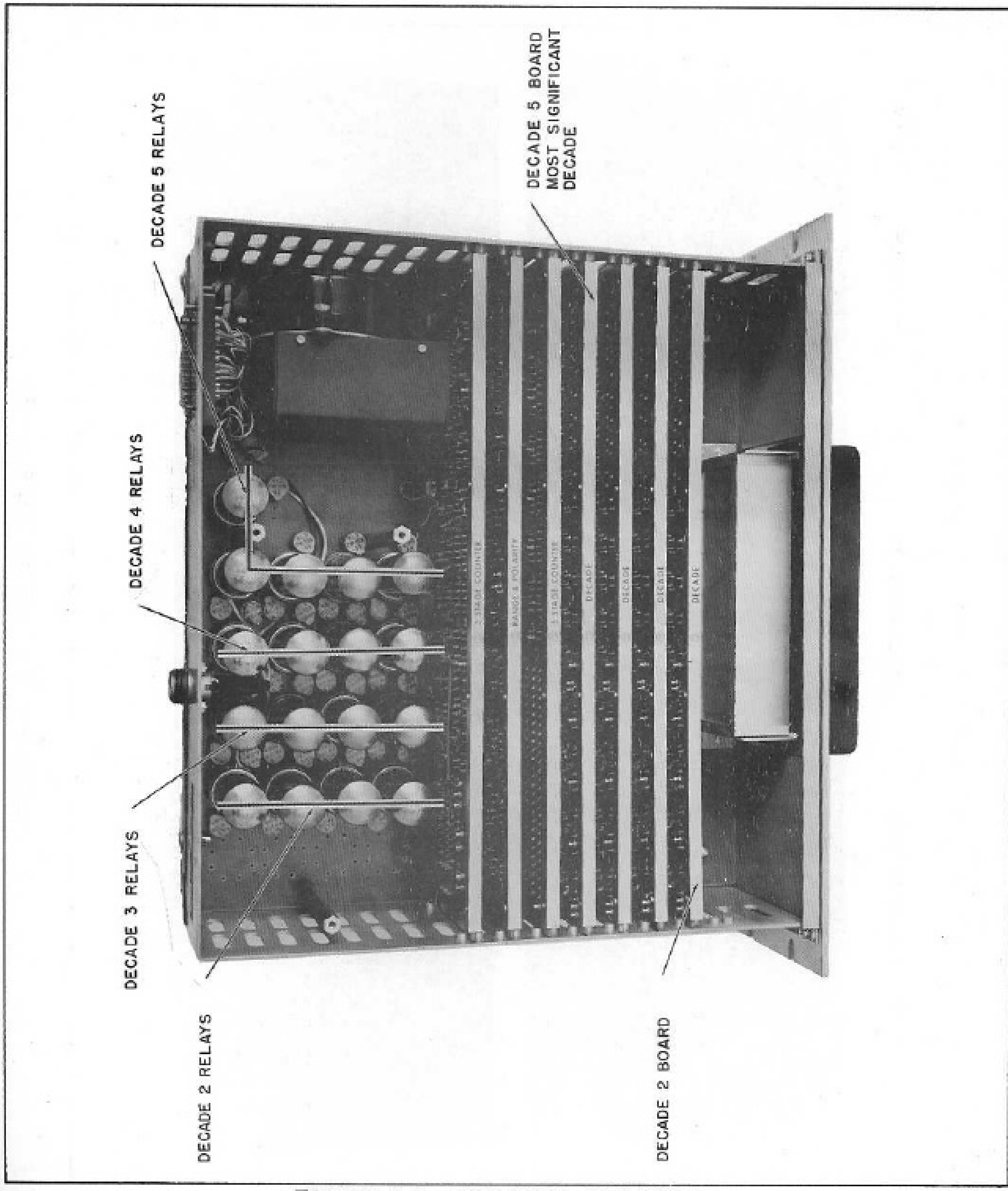


FIGURE 5-3. TOP VIEW, "A" UNIT

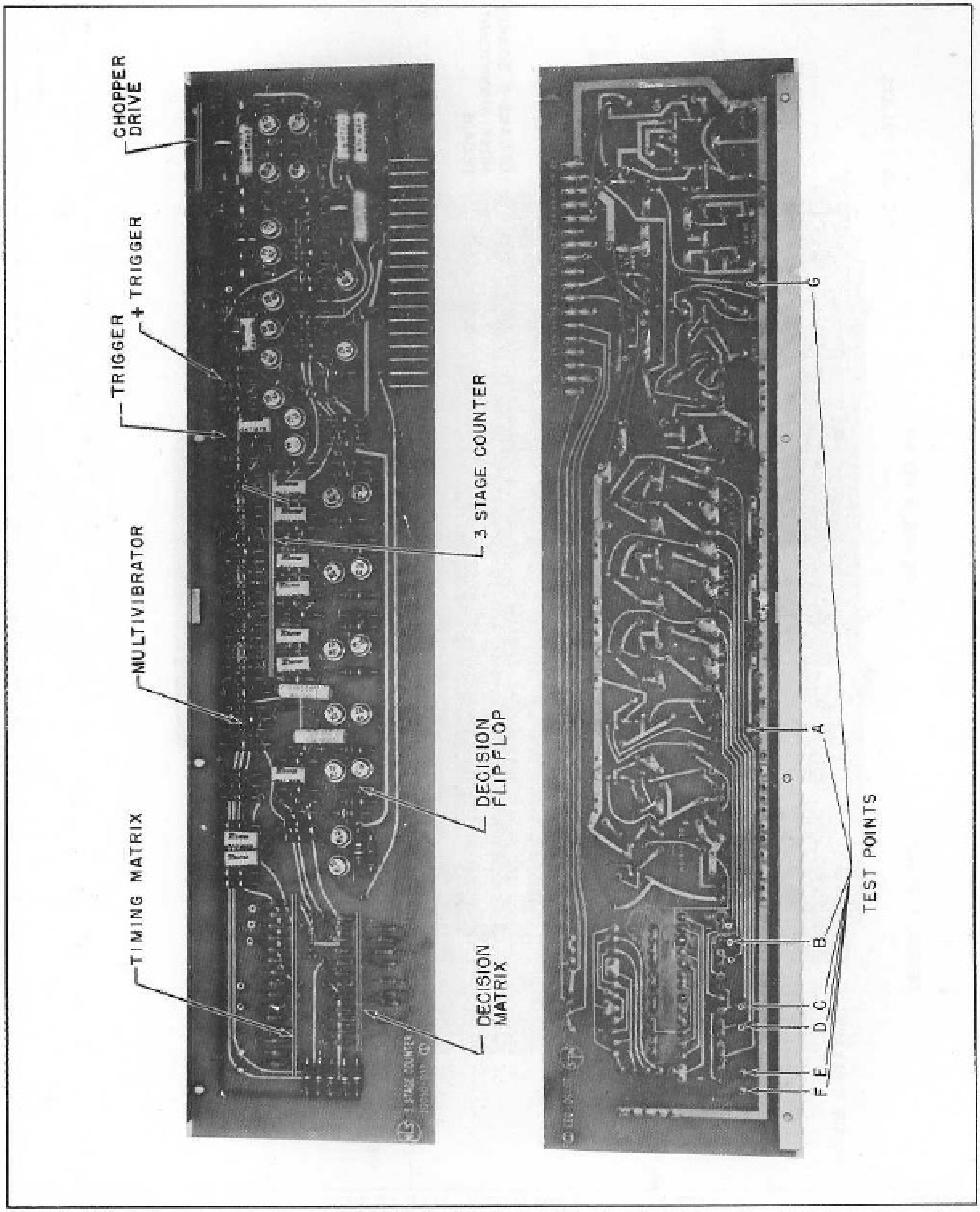


FIGURE 5-4. 3 STAGE COUNTER BOARD

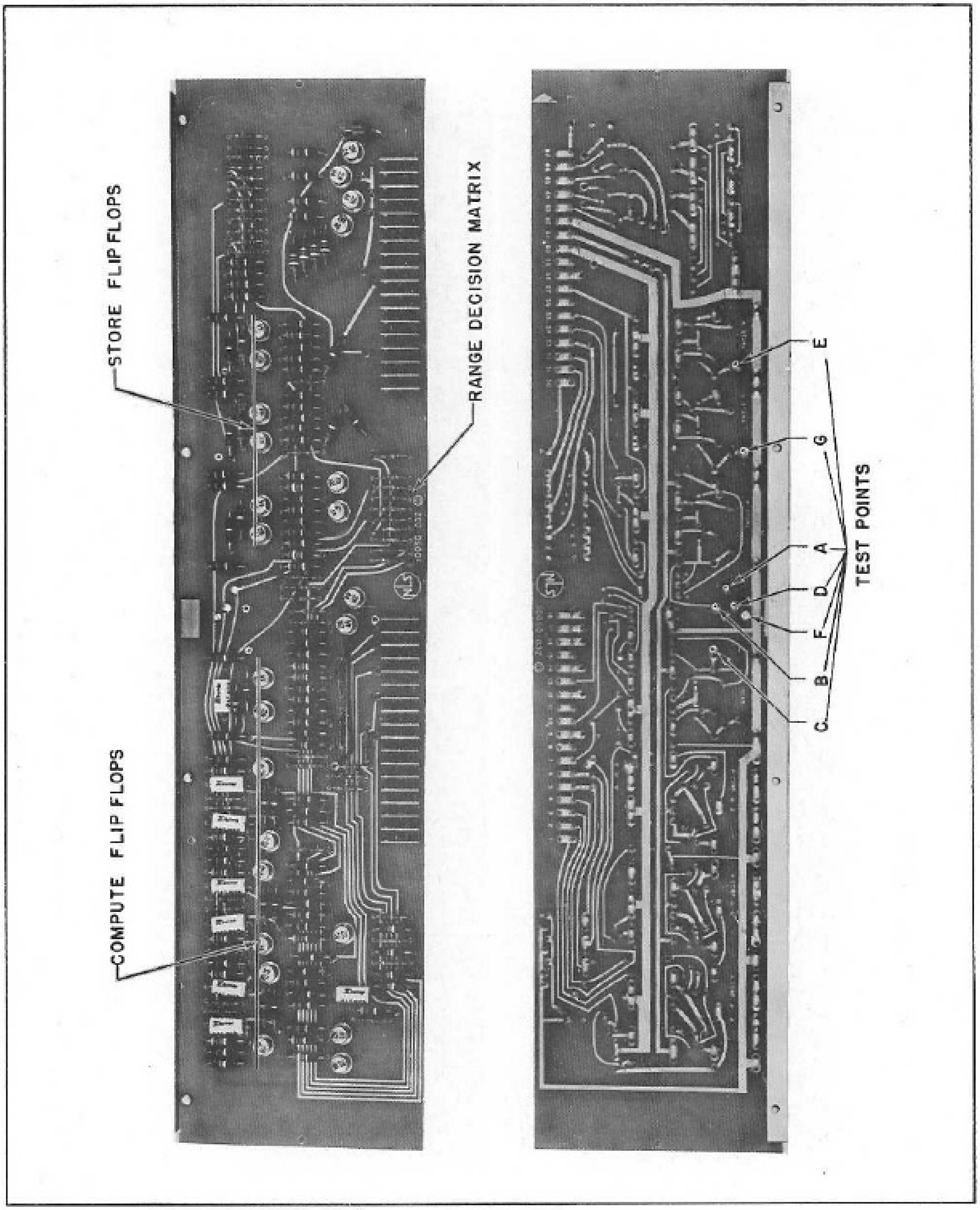


FIGURE 5-5. RANGE 8 POLARITY BOARD

non-linear systems inc.

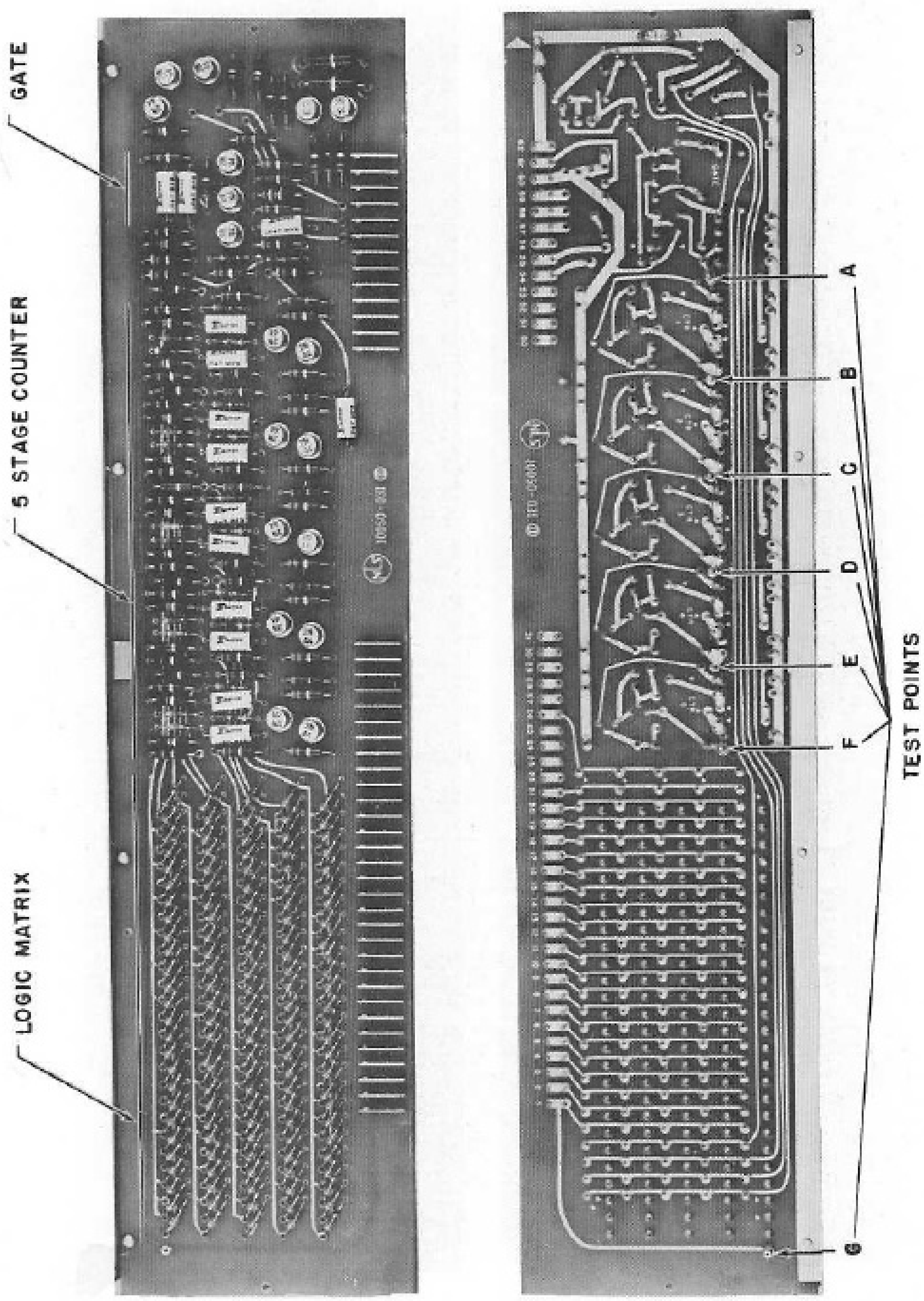


FIGURE 5-6. 5 STAGE COUNTER

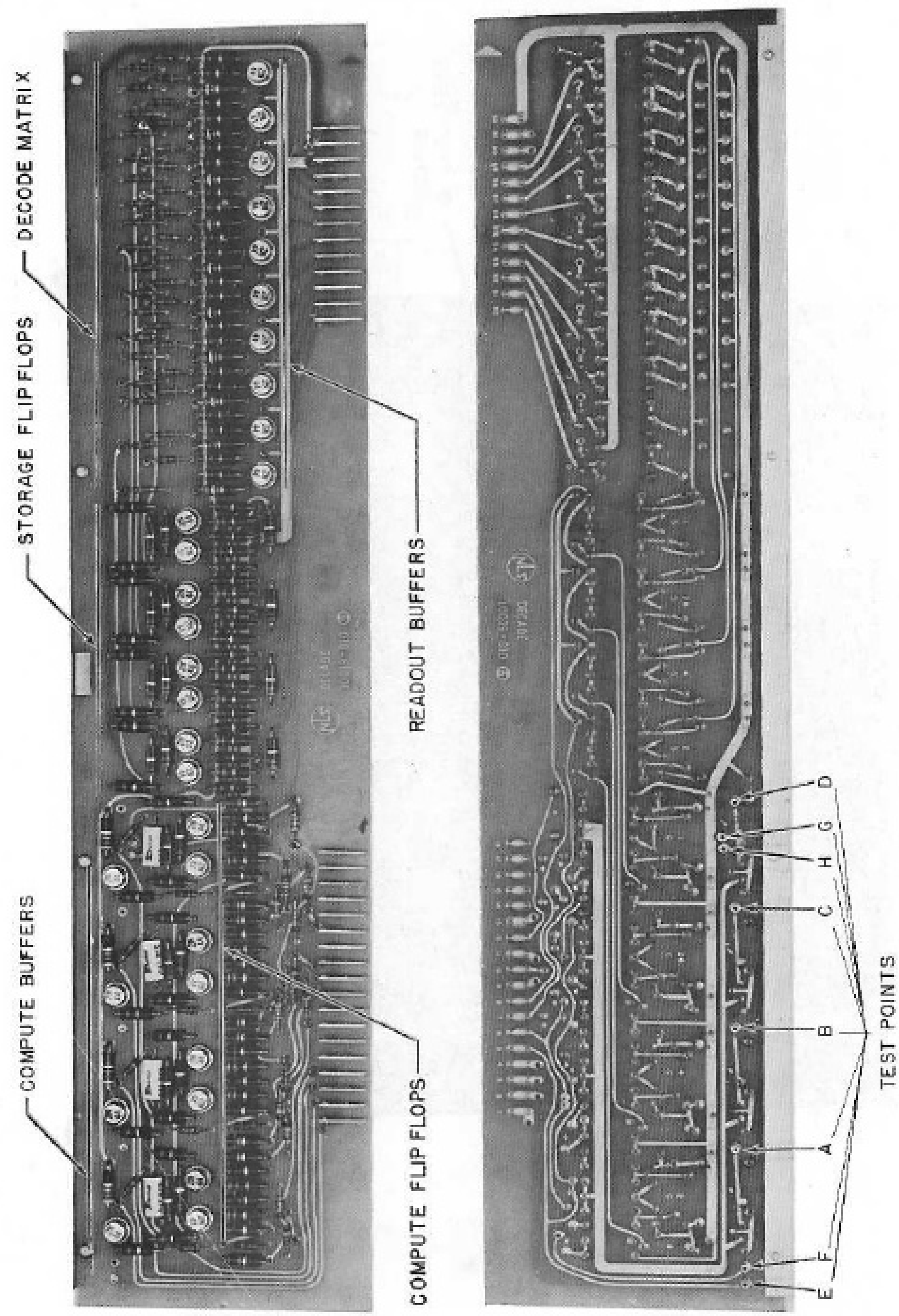


FIGURE 5-7. DECADE BOARD

www.everything4lesstore.com

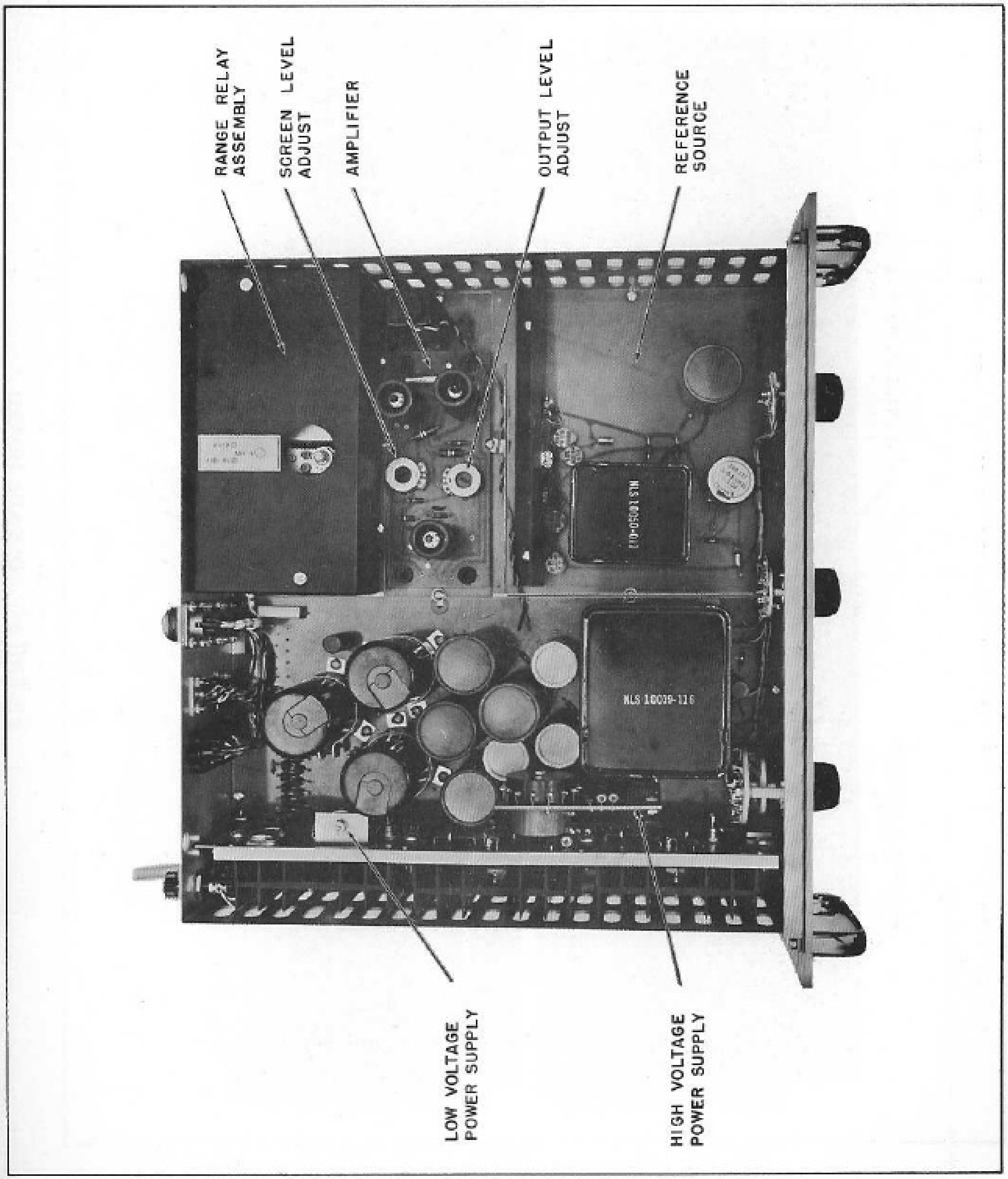
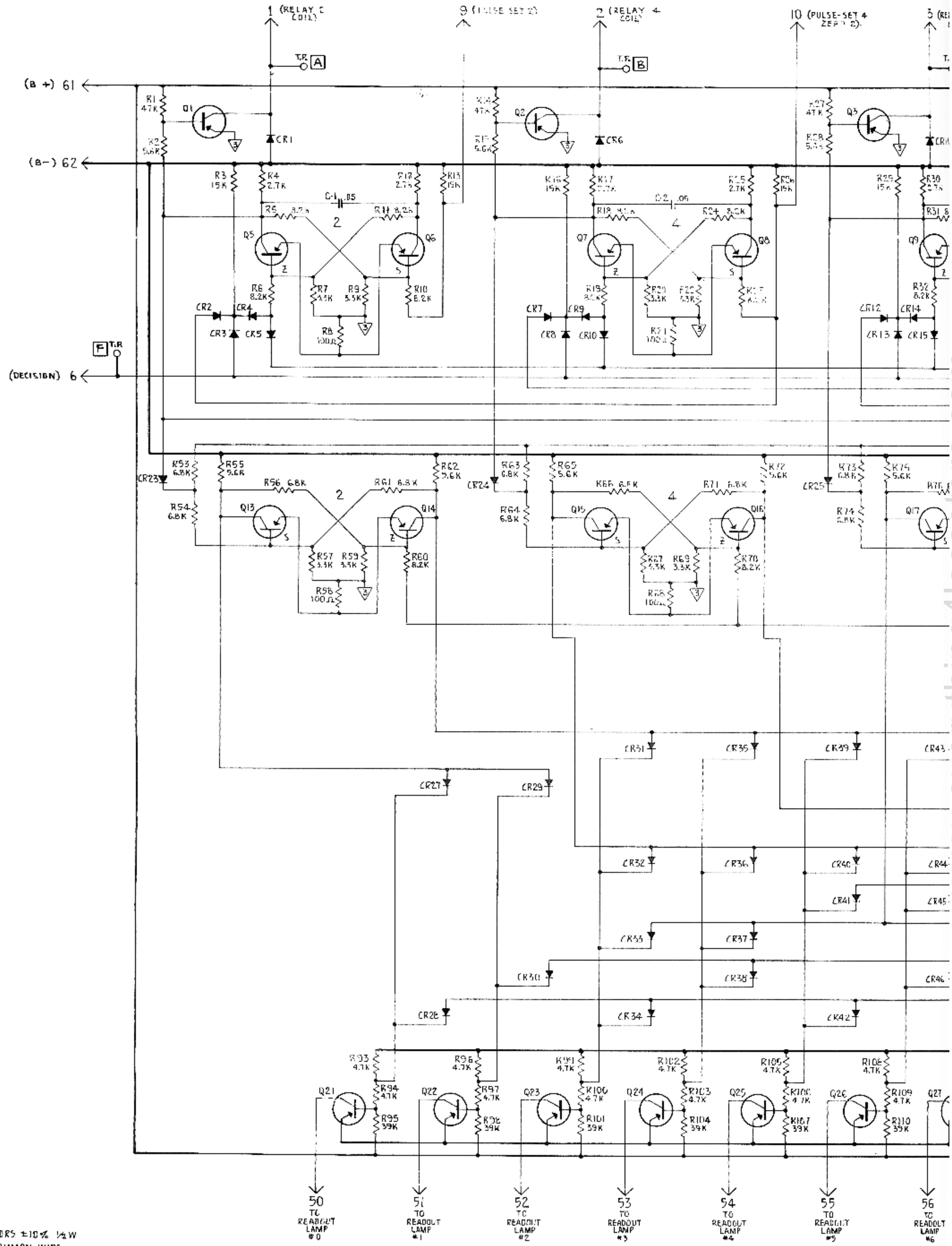
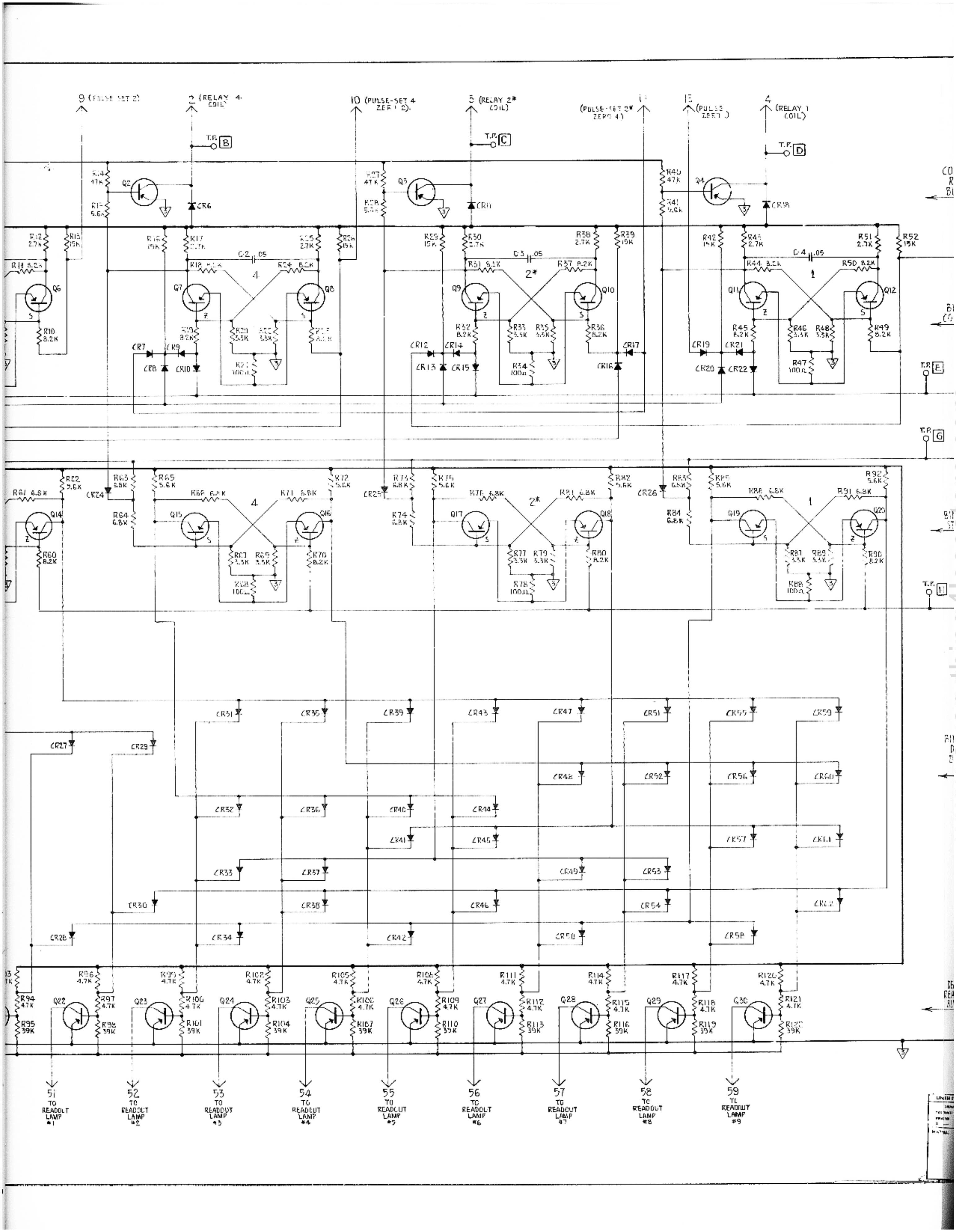


FIGURE 5-8. TOP VIEW, "B" UNIT

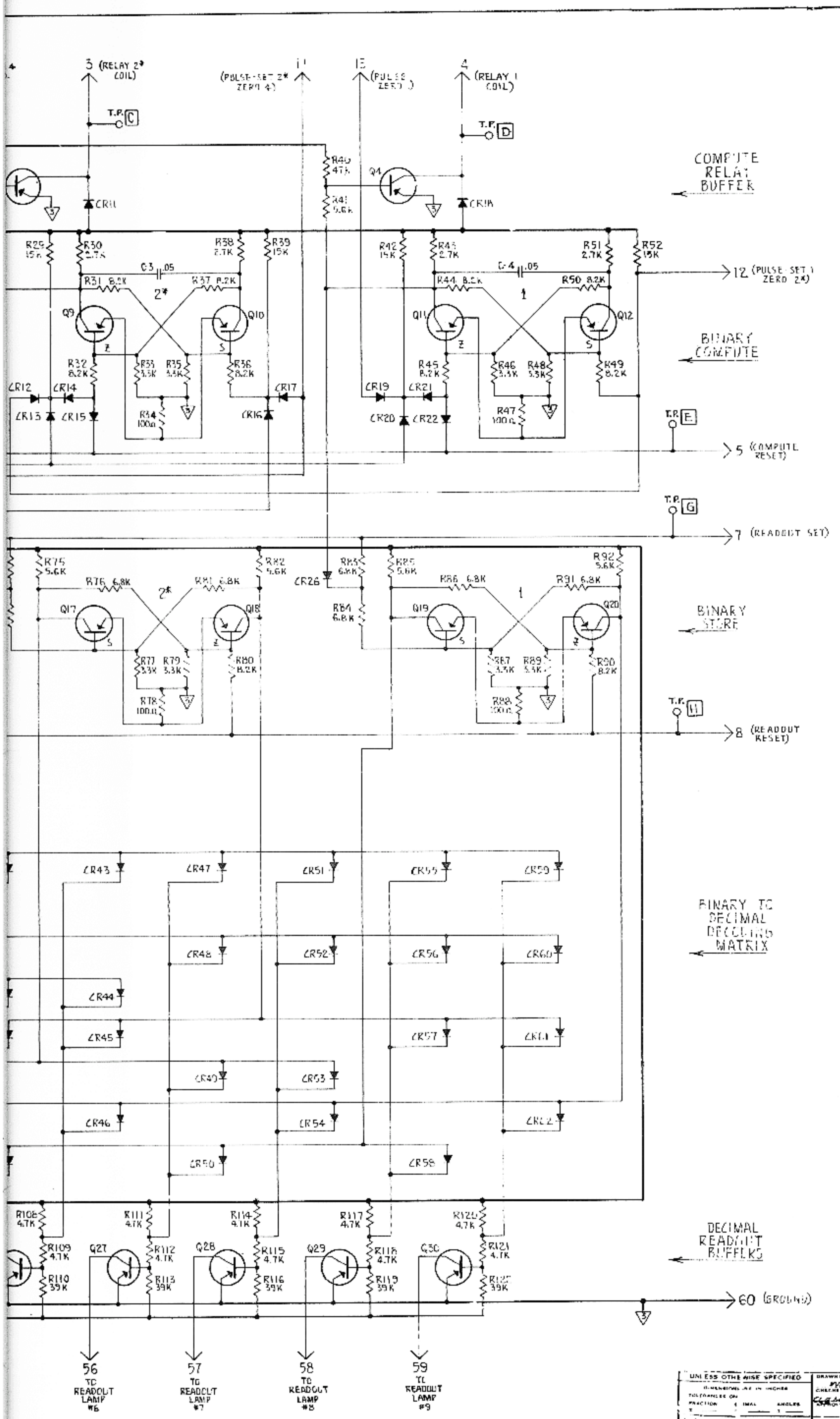


4. ALL RESISTORS ±10% ½W
3 DENOTES COMMON WIRE
2. ALL DIODES TYPE 1N34A
1. ALL TRANSISTORS TYPE 2N44

NOTES: UNLESS OTHERWISE SPECIFIED



9 (PULSE SET 2)
2 (RELAY 4 COIL)
10 (PULSE-SET 4 ZERO 2)
5 (RELAY 2* COIL)
(PULSE-SET 2* ZERO 4)
(PULSE ZERO 1)
4 (RELAY 1 COIL)
51 TO READOUT LAMP #1
52 TO READOUT LAMP #2
53 TO READOUT LAMP #3
54 TO READOUT LAMP #4
55 TO READOUT LAMP #5
56 TO READOUT LAMP #6
57 TO READOUT LAMP #7
58 TO READOUT LAMP #8
59 TO READOUT LAMP #9



10019-010
SHEET 2

1

SYM	SHEET	DESCRIPTION	DATE	APPROVAL
1		ADDED T.P. DESIGNATIONS	8-17-59	

10054	10054-181	1	1
NEXT ASSY	USED ON		
APPLICATION			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTION DECIMAL ANGLES
MATERIAL
FINISH

DRAWN BY
CHECKED BY
APPROVED BY
DATE

SCHEMATIC
DECADE
"A" UNIT
MODEL 20 SERIES

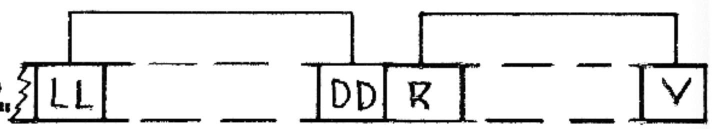
NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER
10019-010
SHEET 2

SCALE

SYM.	EFFE
1	

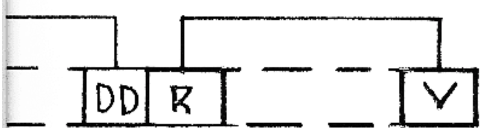
MRE-34P-J-TCH-6
MALE GUIDE PIN AT "FF"



UNLESS OTHERWISE SPECIFIED	DRAWN BY WALLIN	DATE 17 SEPT '58	TITLE
DIMENSIONS ARE IN INCHES	CHECKED BY JIM CLEMENT	DATE 17 SEPT 58	PLU
TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	APPROVED BY	DATE	
MATERIAL	FINISH		M
			SCALE

DRAWING NUMBER 10019-059 SH 2 | 1

REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		ADDED JUMPER R TO V	12-10-58	12-11-58



NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

DATE 17 SEPT '58
DATE 17 SEPT 58
DATE

TITLE

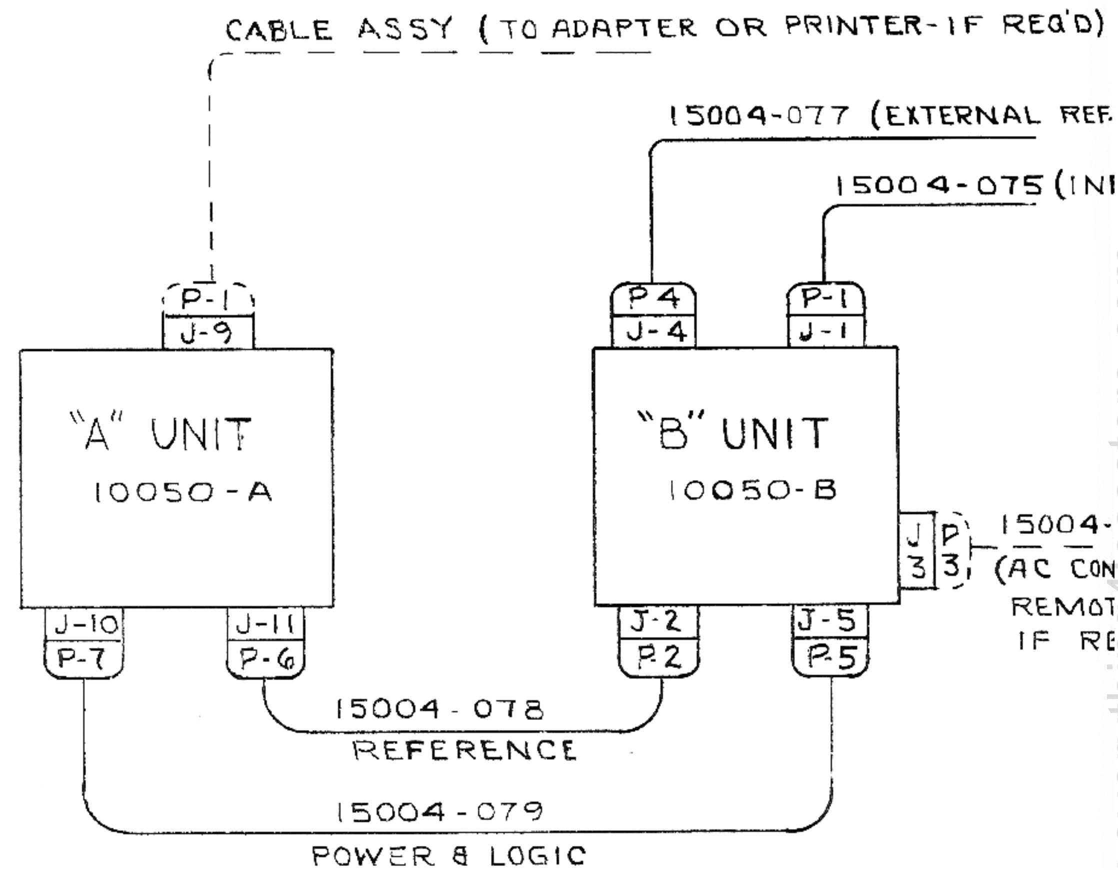
PLUG - JUMPER

MODEL 24

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER 10019-059

SCALE | WT. | SHEET 2 OF



1. FOR SCHEMATICS REFER TO THE FOLLOWING DRAWINGS:
A UNIT: 10019-010, 10050-031, 10050-032, 10050-033, 10050-034 (ALL SHEET 2)
B UNIT: 10050-035, 10050-008, 10050-022 (ALL SHEET 2)

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE S
DIMENSIONS ARE IN I
TOLERANCES ON
FRACTION ± — DECIMAL ± —
MATERIAL
—

10050 SHT 4 | 1

REVISIONS

SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		"CABLE ASSY" WAS 15004-059	9-10-59 MTS	H Clement

)

F.)

IPUT)

-076

NVERTER &

TE CONTROL

EQ'D)

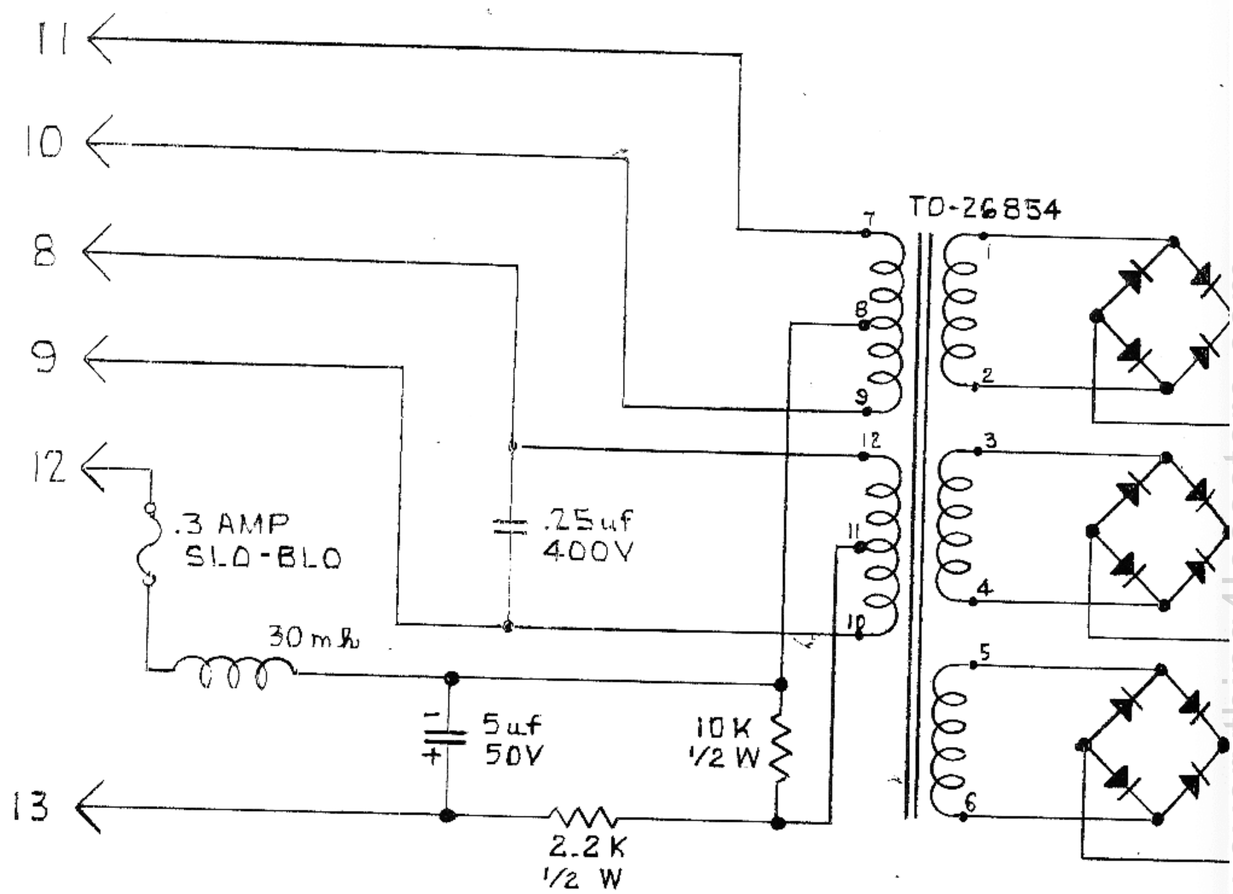
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

SPECIFIED	DRAWN BY SHACKLETON	DATE 6-9-59	TITLE
INCHES	CHECKED BY, SOULE	DATE 6-10-59	BLOCK DIAGRAM - VOLT-OHMMETER
ANGLES ±—	APPROVED BY H Clement	DATE 6-10-59	MODEL M24
	FINISH —		SCALE NONE / WT.

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER 10050

SHEET 4 OF



UNLESS OTHERWISE SPE

DIMENSIONS ARE IN INC

TOLERANCES ON

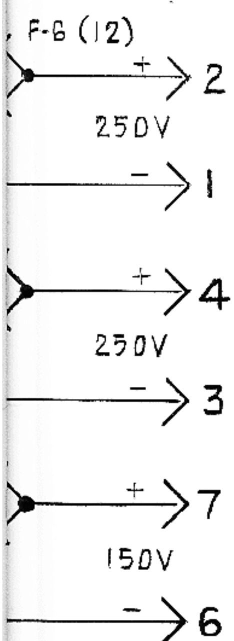
FRACTION ± DECIMAL ±

MATERIAL

10050-008
SHEET 2

2

REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		REMOVED TWO 2N375 CONN. TO TRANSFORMER & "13"; ADDED FUSE	6-29-59 MTS	6-29-59 H Clement
2		ADDED .25uf-400V CAP.	7-10-59	H. Clement



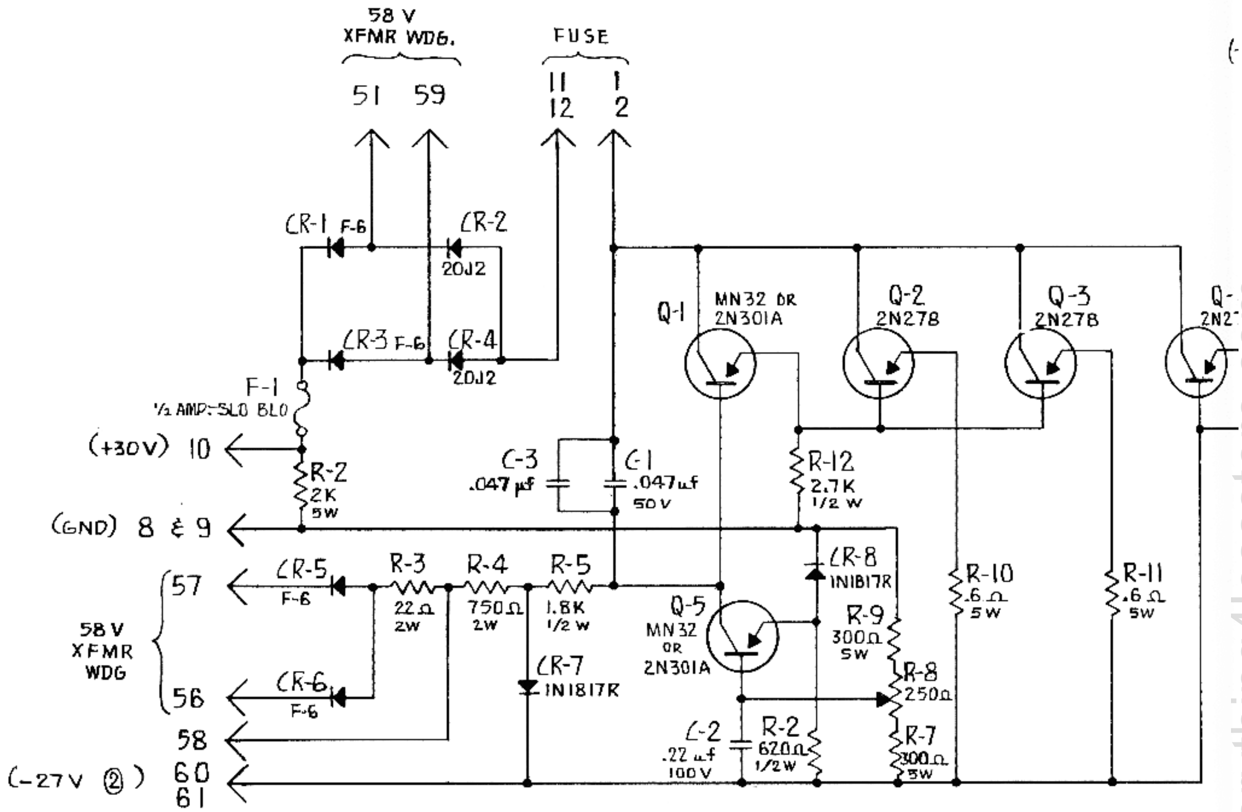
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

SPECIFIED	DRAWN BY WALLIN	DATE 23 JAN '59	TITLE SCHEMATIC— AMPLIFIER POWER SUPPLY
INCHES	CHECKED BY J. CLEMENT	DATE 1-26-59	
ANGLES ±	APPROVED BY H Clement	DATE 1-26-59	
	FINISH		
			SCALE / WT.

NLS NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

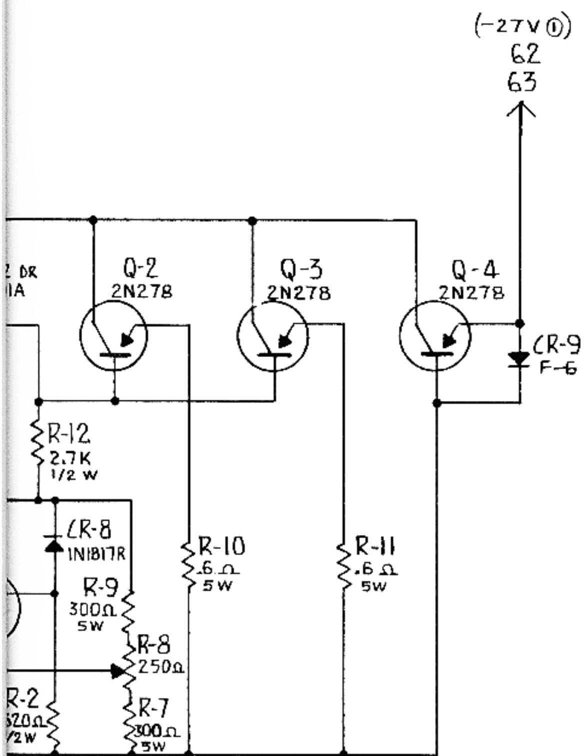
DRAWING NUMBER 10050-008

SHEET 2 OF



UNLESS OTHERW
DIMENSIONS AR
TOLERANCES ON
FRACTION DECIM
± ±
MATERIAL

REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		ADDED C-3, C-1 WAS .05 µf REMOVED R-1 R-7 WAS 100Ω, ADDED	8 May 59 ARW	MTS H Clement



10050-022
SHEET 2

1

10054-155	10054-158	1	1
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTION ± DECIMAL ± ANGLES ±
MATERIAL

		DATE
DRAWN BY	WALLIN	3 FEB '59
CHECKED BY	J CLEMENT	2-11-59
APPROVED BY	HLC	3-3-59

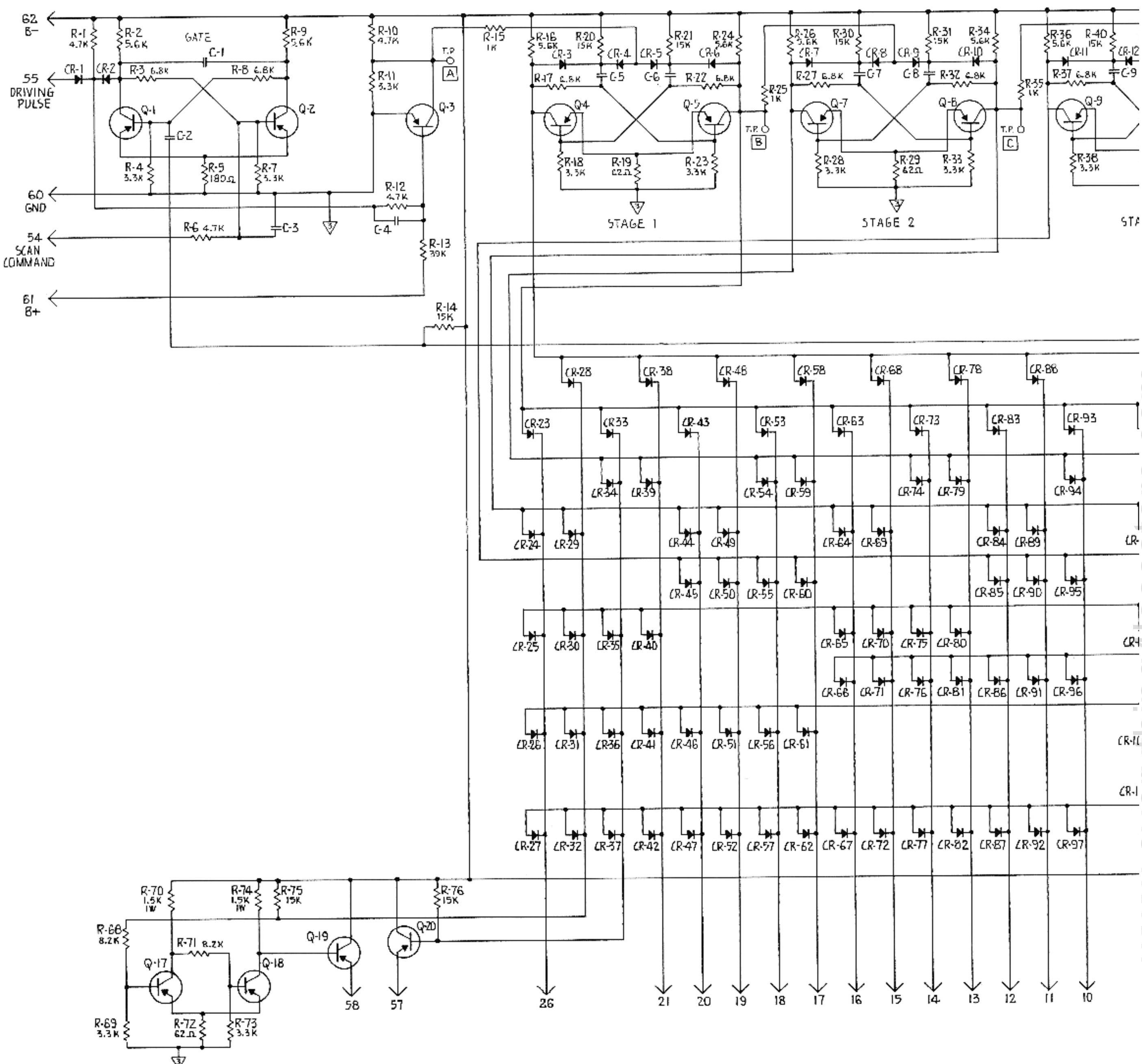
FINISH

TITLE
SCHEMATIC-
POWER SUPPLY - LOW VOLTAGE
"B" UNIT
MODEL 70 SERIES

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER
10050-022

SCALE
WT.
SHEET 2 OF

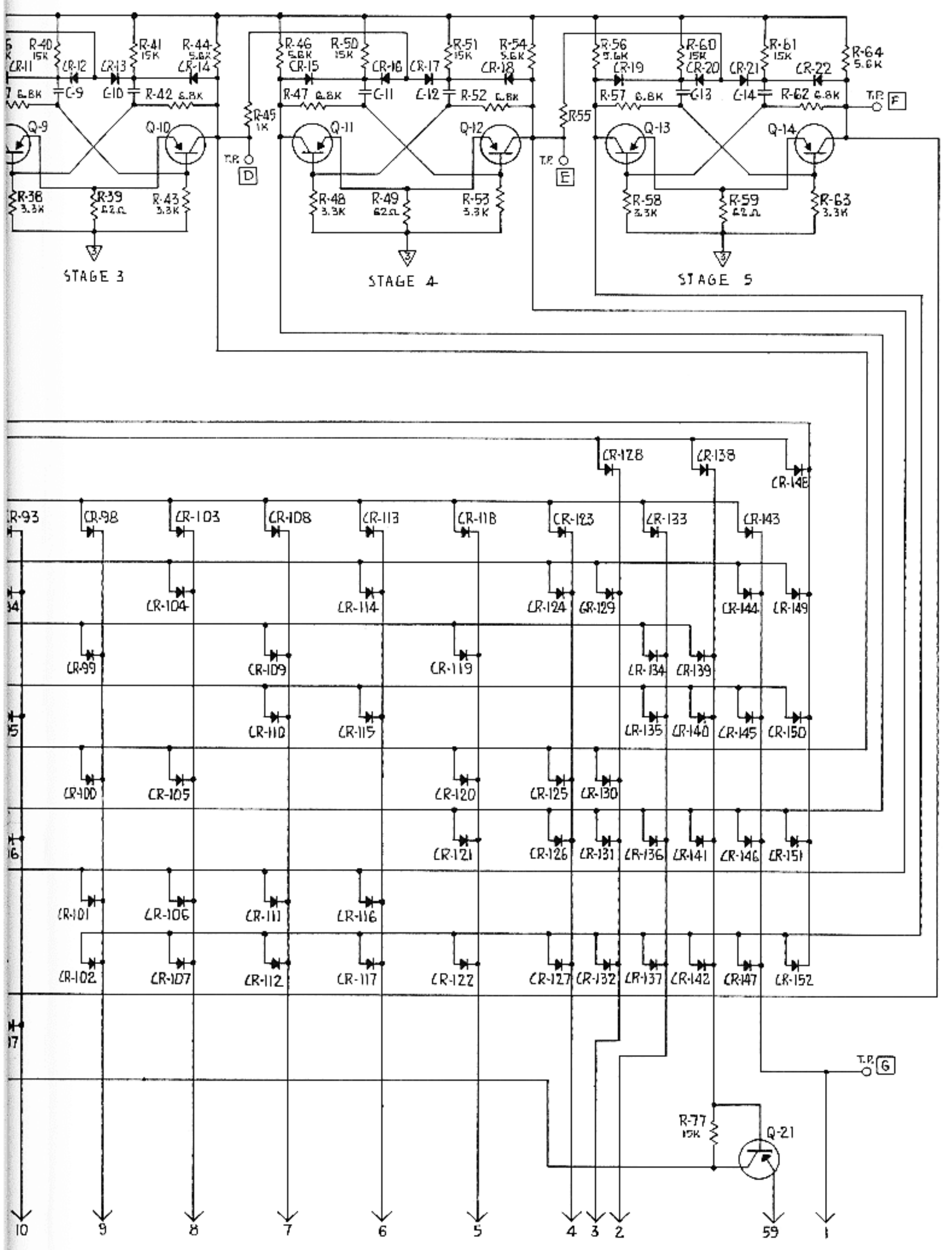


MATRIX OUTPUTS & FUNCTIONS						
COUNTER POS.					PIN #	FUNCTION
5	4	3	2	1		
0	0	0	0	0	—	ZERO GATE
0	0	0	0	1	1	⊕
0	0	0	1	0	59	COMPUTE RESET
0	0	0	1	1	2	⊕
0	0	1	0	0	3	⊕
0	0	1	0	1	4	⊕
0	0	1	1	1	5	⊕
0	1	0	0	1	6	SET DECADE 5, BIT 2 ⊕
0	1	0	1	1	7	" 4
0	1	1	0	1	8	" 2*
0	1	1	1	1	9	" 1
1	0	0	0	1	10	4 2
1	0	0	1	0	11	" 4
1	0	0	1	1	12	" 2*
1	0	1	0	0	13	" 1
1	0	1	0	1	14	3 2
1	0	1	1	0	15	" 4
1	0	1	1	1	16	" 2*
1	1	0	0	0	17	" 1
1	1	0	0	1	18	2 2
1	1	0	1	0	19	" 4
1	1	0	1	1	20	" 2*
1	1	1	0	0	21	" 1
1	1	1	0	1	57	READOUT RESET
1	1	1	1	0	58	READOUT SET
1	1	1	1	1	26	PRINT PULSE

⊕ SEE RANGE & POLARITY DWG 10050-032

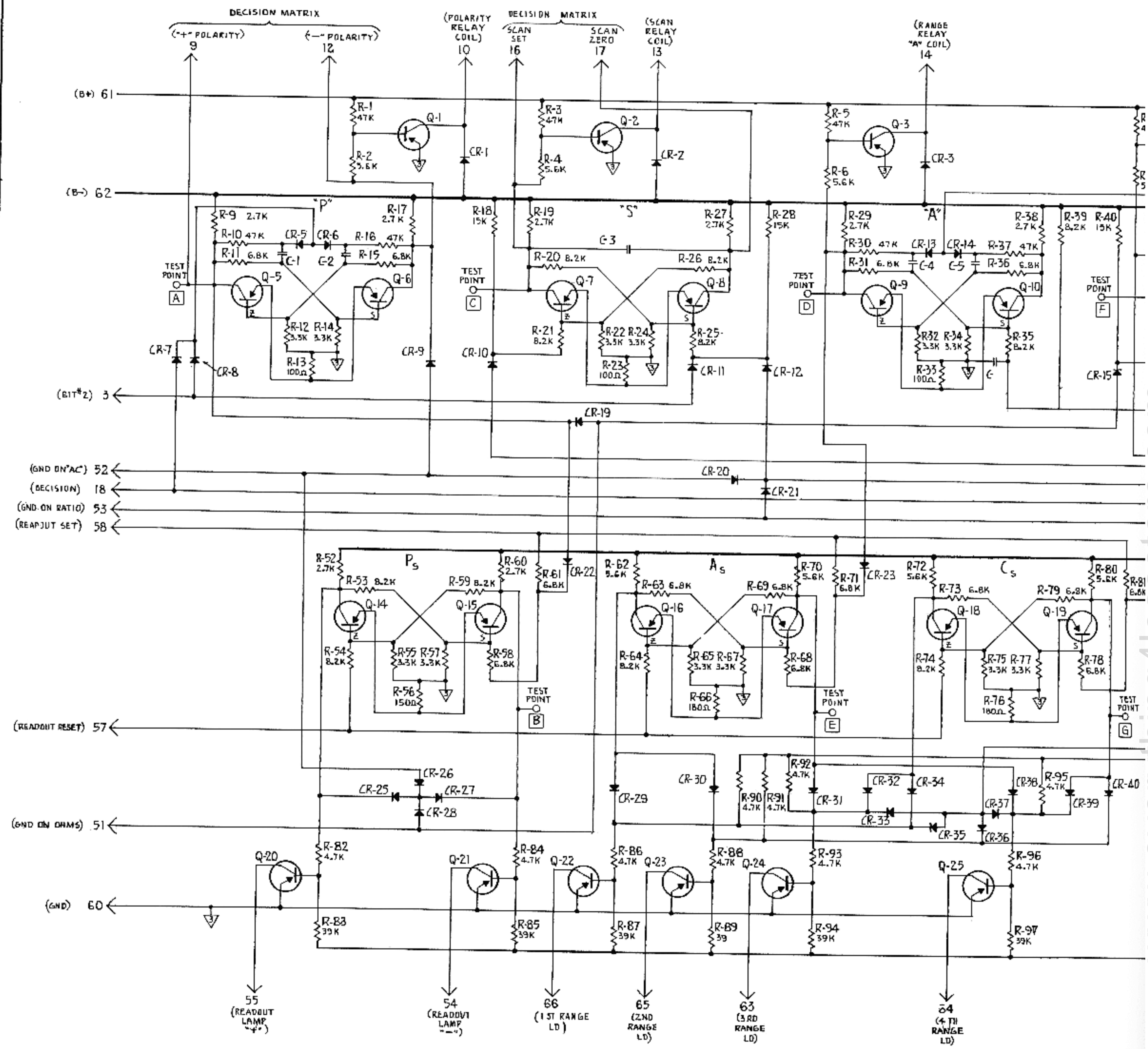
5. ALL RESISTORS ARE 1/2 W
4. ALL CAPACITORS .047 μf.
3. ▽ DENOTES COMMON WIRE.
2. ALL DIODES TYPE 1N34A
1. ALL TRANSISTORS TYPE 2N44.
NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS				
SYM	EFFECT	DESCRIPTION	DATE	APPROVAL
1		ADDED VALUES TO R-2, R-9, & R-5	8 May 59 ARW	5-8-5-9
2		ADDED IDENTIFICATION LETTERS A THRU G TO TEST POINTS	8-17-59 ARW	



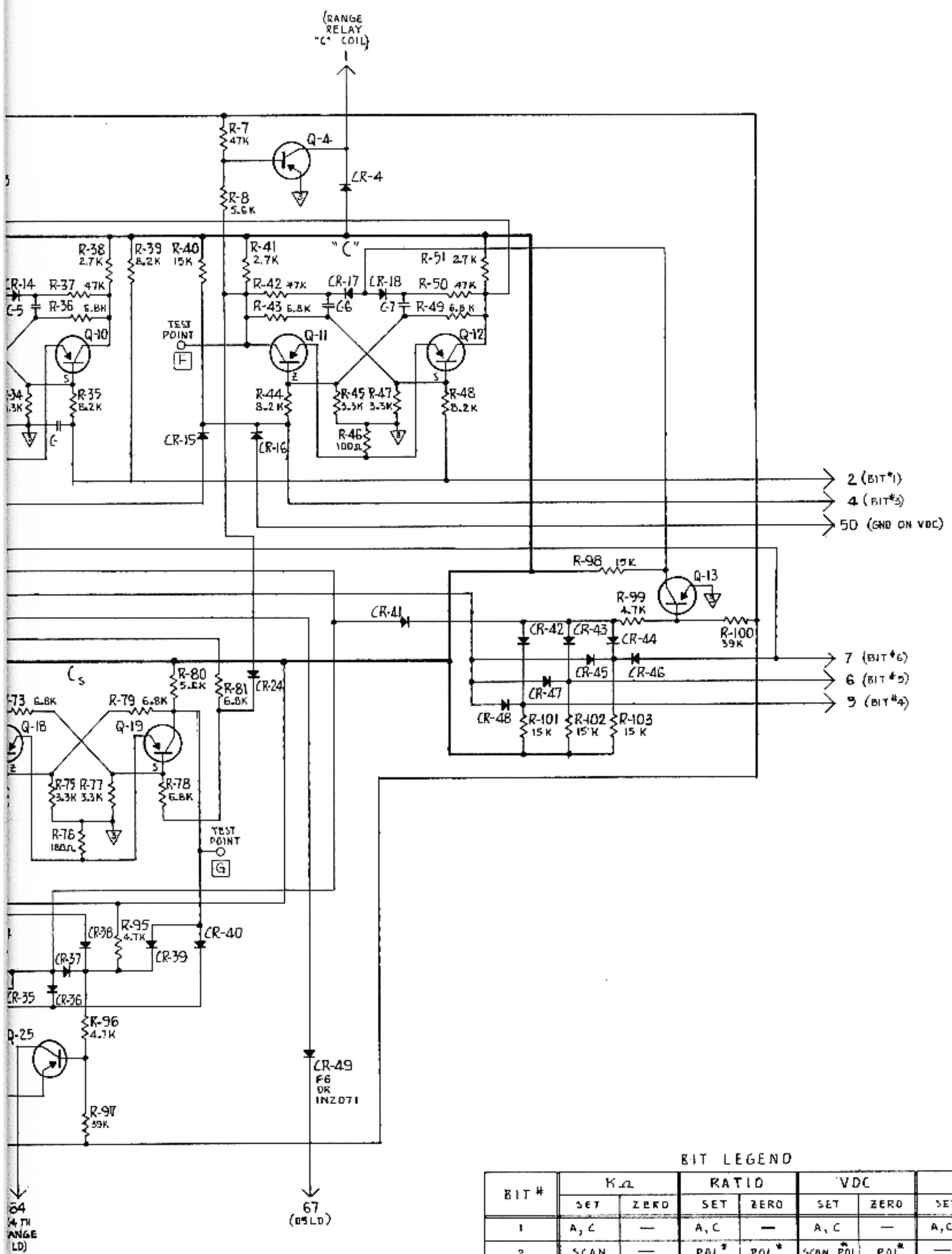
10050-031
SHEET 2
2

UNLESS OTHERWISE SPECIFIED	DRAWN BY A.R. WALLIN	DATE 5-2-59	TITLE SCHEMATIC 5 STAGE COUNTER	NON-LINEAR SYSTEMS INC. DEL MAR AIRPORT DEL MAR, CALIFORNIA
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	CHECKED BY JIM CLEMENT	DATE 3-27-59		
	APPROVED BY H Clement	DATE 8-27-59		DRAWING NUMBER 10050-031
MATERIAL	FINISH		SCALE	WT	SHEET 2 OF



4. ALL CAPACITORS .047 µf
DENOTES COMMON WIRE
2. ALL DIODES TYPE 1N34A
1. ALL TRANSISTORS TYPE 2N44
NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS				
SYM	EFFECT	DESCRIPTION	DATE	APPROVAL
1		R-9, R-17, R-29, R-38, R41 & R51 WERE 5.6K EA. ADDED ALTERNATE TO CR-49	8 MAY 59	5-8-59 RWJ
2		ADDED T.P. IDENTIFICATION LETTERS A THRU G	17 AUG 59	A Clement



BIT LEGEND

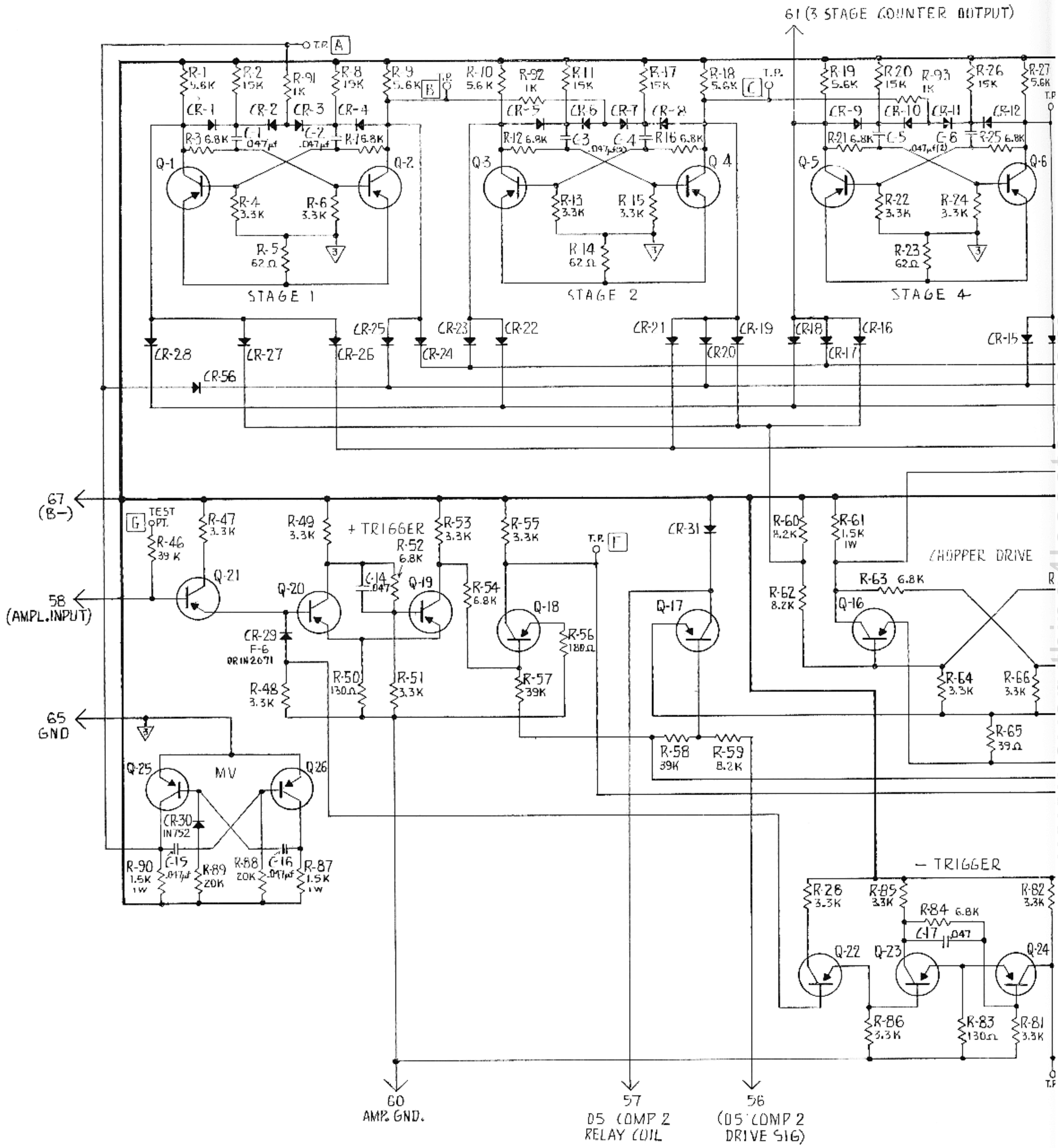
BIT #	KΩ		RATIO		VDC		VAC	
	SET	ZERO	SET	ZERO	SET	ZERO	SET	ZERO
1	A, C	—	A, C	—	A, C	—	A, C	—
2	SCAN	—	POL.*	POL.*	SCAN, POL*	POL*	—	—
3	—	—	—	C	—	—	—	C
4	—	C*	—	—	—	C*	—	—
5	C*	A*	—	—	C*	A*	—	—
6	—	SCAN, C*	—	—	—	SCAN, C*	—	—

* WITH DECISION

10050-032
SHEET 2

2

UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE	TITLE	
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	WALLIN CHECKED BY V. CLEMENT APPROVED BY H. Clement	5-6-59 5-27-59 5-27-59	SCHEMATIC — RANGE & POLARITY	NON-LINEAR SYSTEMS INC. DEL MAR AIRPORT DEL MAR, CALIFORNIA
MATERIAL	FINISH		SCALE / WT	DRAWING NUMBER 10050-032 SHEET 2 OF



4. ALL RESISTORS 1/2 W.

3 DENOTES COMMON WIRE.

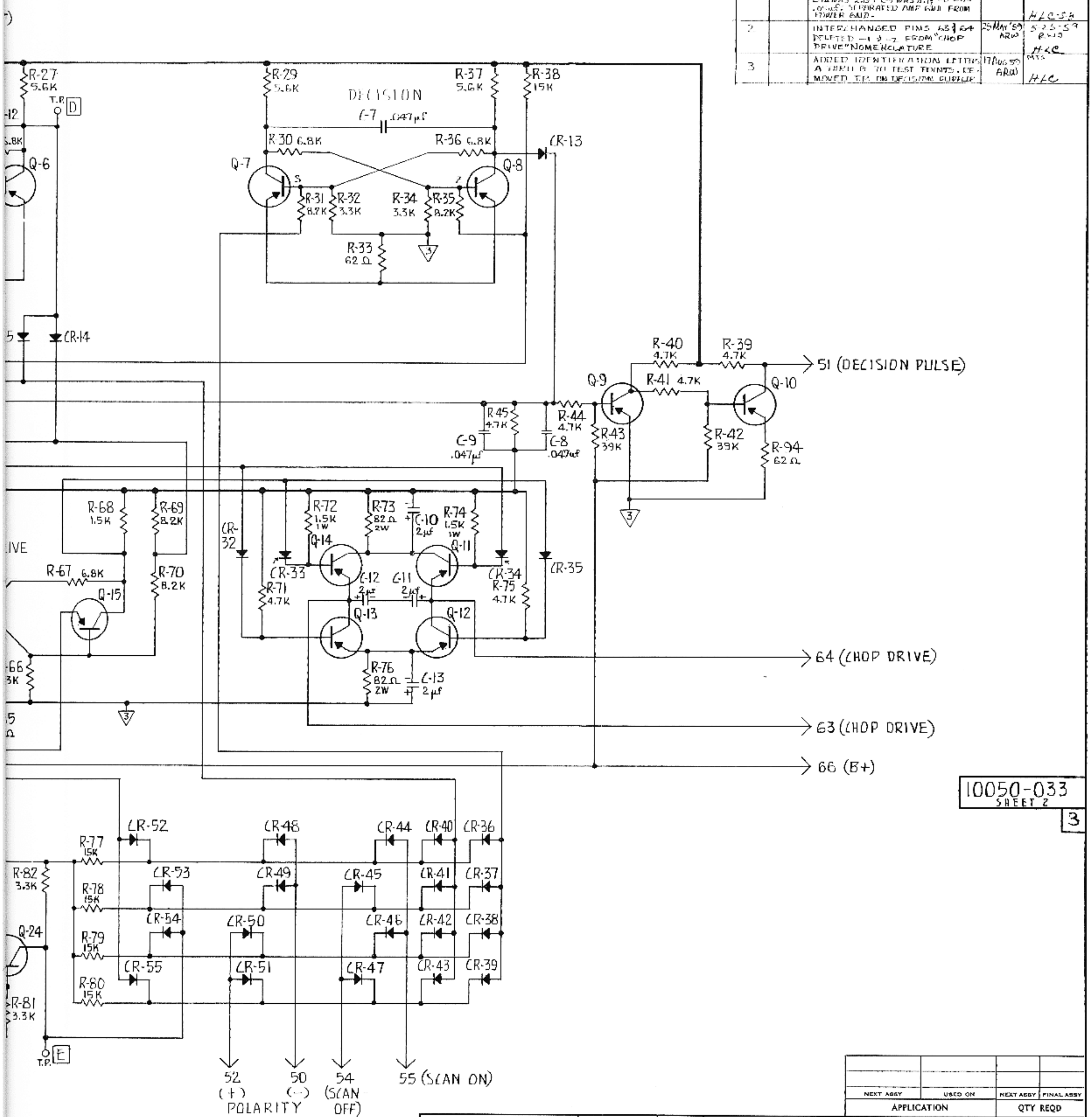
2. ALL DIODES TYPE IN34A

1. ALL TRANSISTORS TYPE 2N44.

NOTES: UNLESS OTHERWISE SPECIFIED:

REVISIONS

SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		[illegible] WAS [illegible] ADDED VALUES OF [illegible] ADDED [illegible] WAS 47K; [illegible] WAS .05μf; [illegible] ADDED [illegible] WAS [illegible] WAS [illegible] SEPARATED AMP GND FROM POWER GND.	4-24-59 ARW	[illegible] HLC-5-8
2		INTERCHANGED PINS 63 & 64 DELETED -1 & -2 FROM "CHOP DRIVE" NOMENCLATURE	25 MAY '59 ARW	5-25-59 [illegible] HLC
3		ADDED IDENTIFICATION LETTERS A THRU G TO TEST POINTS. REMOVED T.P. ON DECISION CIRCUIT	17 Aug 59 ARW	MTS HLC

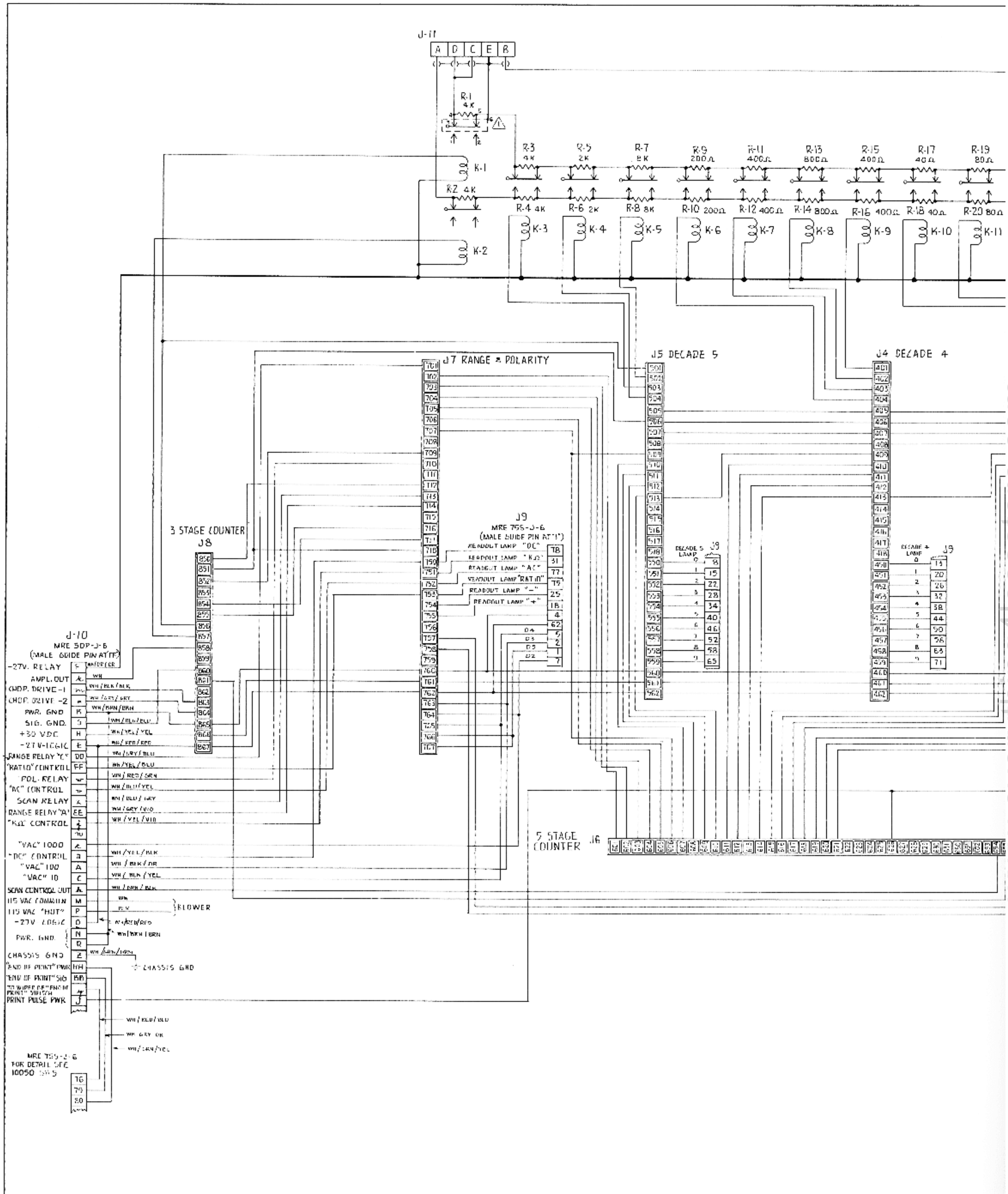


NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

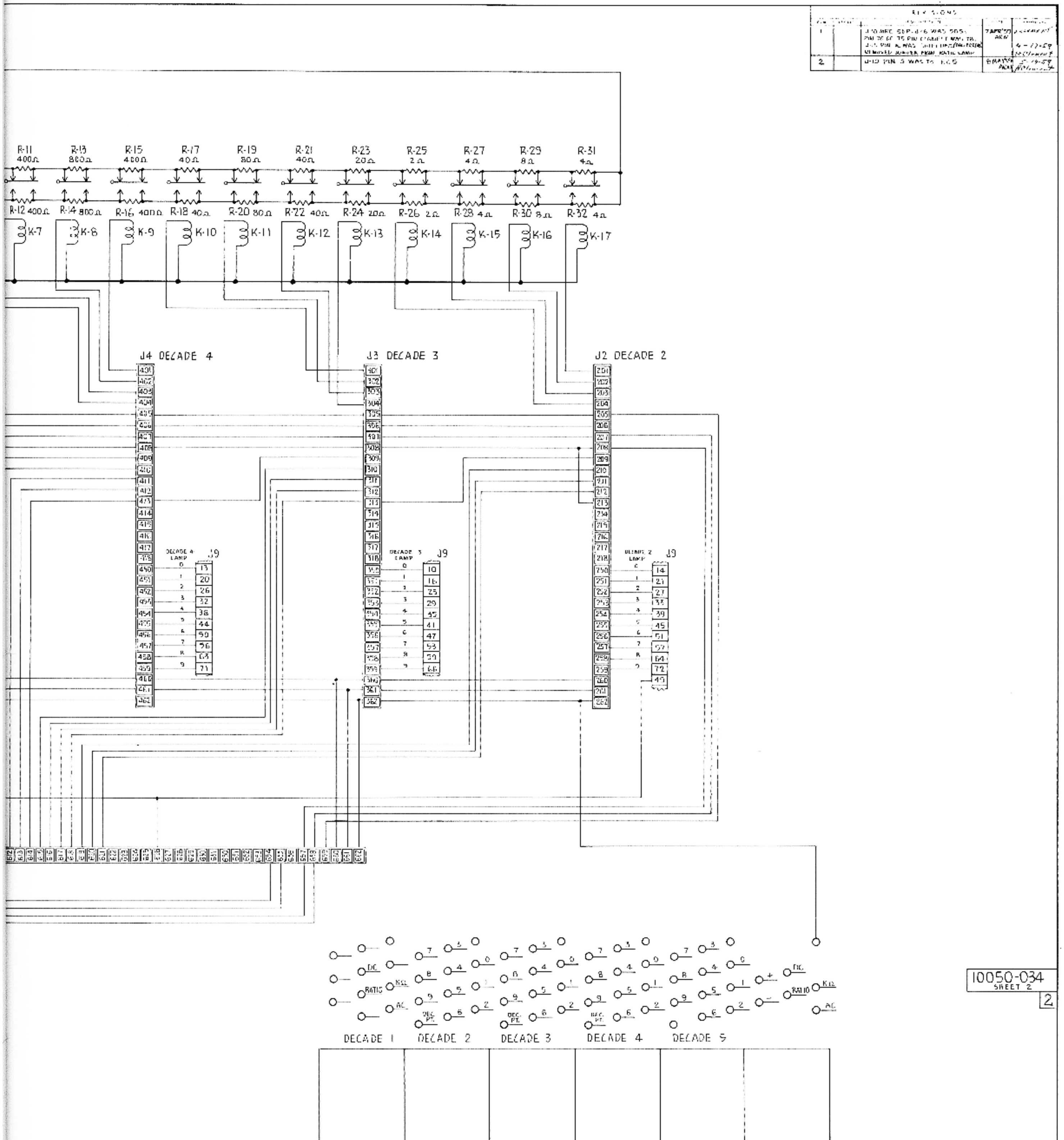
UNLESS OTHERWISE SPECIFIED	DRAWN BY A. P. WALLIN	DATE 13 FEB '59	TITLE
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	CHECKED BY V. CLEMENT	DATE 6 MAR '59	SCHEMATIC - 3 STAGE COUNTER
	APPROVED BY H. Clement	DATE 3-17-59	
MATERIAL	FINISH		SCALE / WT.

NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER 10050-033
SHEET 2 OF



4. ALL RELAYS HG3056.
3. FOR PRINTED CIRCUITRY REFER TO NLS DWG 10090-034 SH 1.
2. ON 4 DECADE INSTRUMENT ONLY - JUMPER RATIO TO RATIO, KΩ TO KΩ, AC TO AC & DC TO DC
1. PIN NO'S TYPICAL - RELAYS NO. 1 THRU 24 - CONNECT ALL #6 PINS
NOTES: UNLESS OTHERWISE SPECIFIED



10050-034
SHEET 2

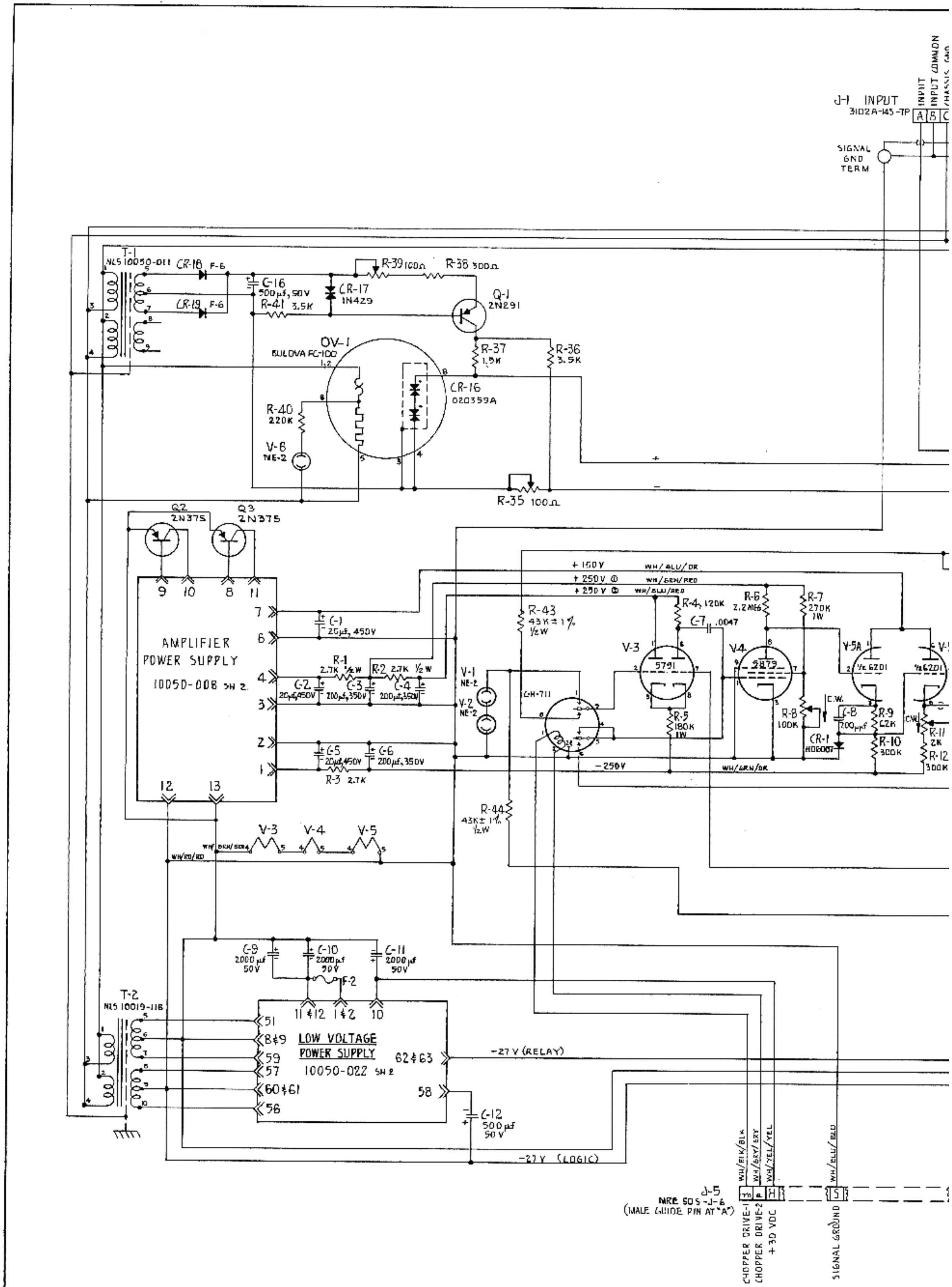
2

DRAWN BY A. R. WALLIN 25 MAR '59
CHECKED BY J. CLEMENT
APPROVED BY H. Clement

TITLE
SCHEMATIC
BASE

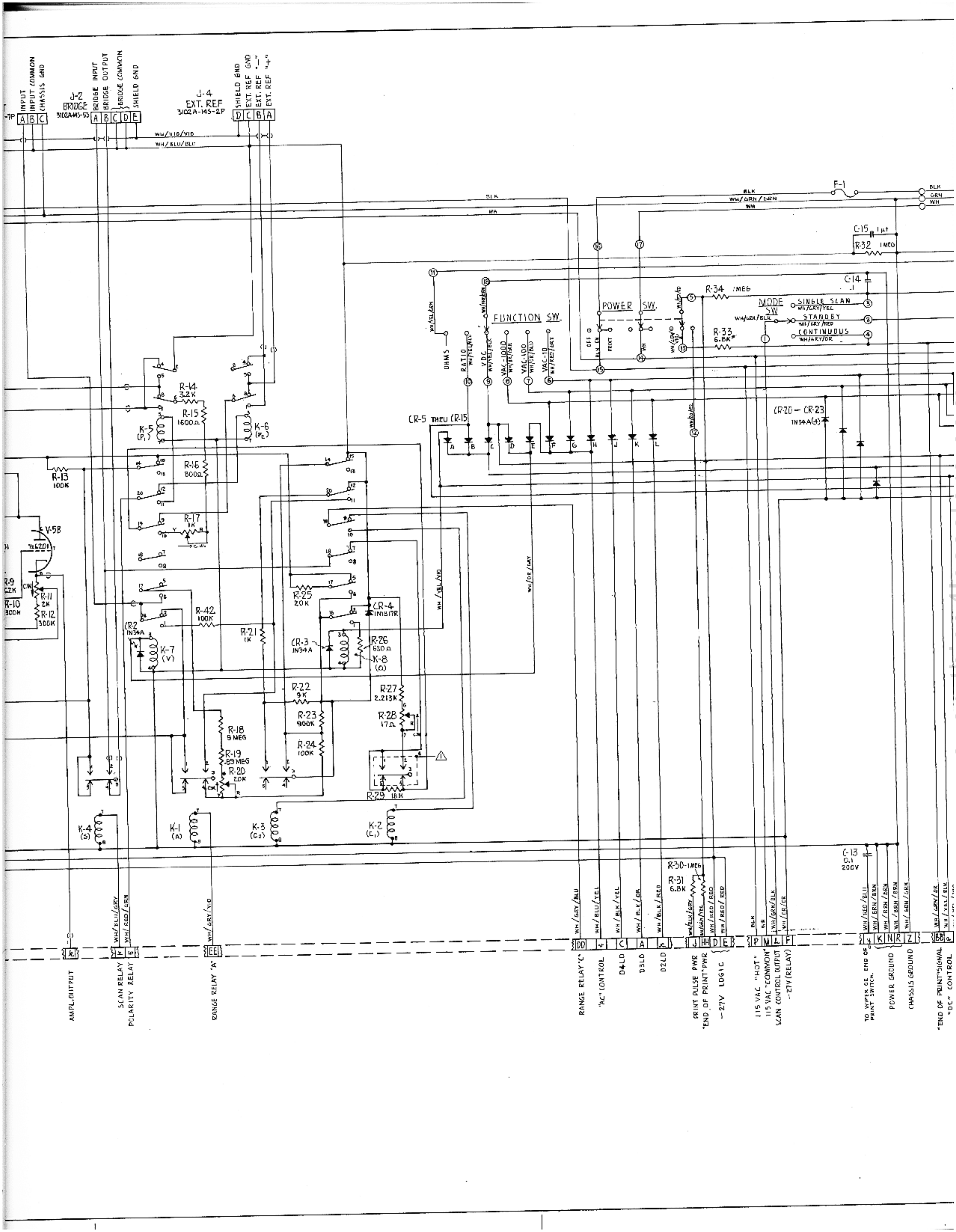
NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR CALIFORNIA

DRAWING NUMBER
10050-034



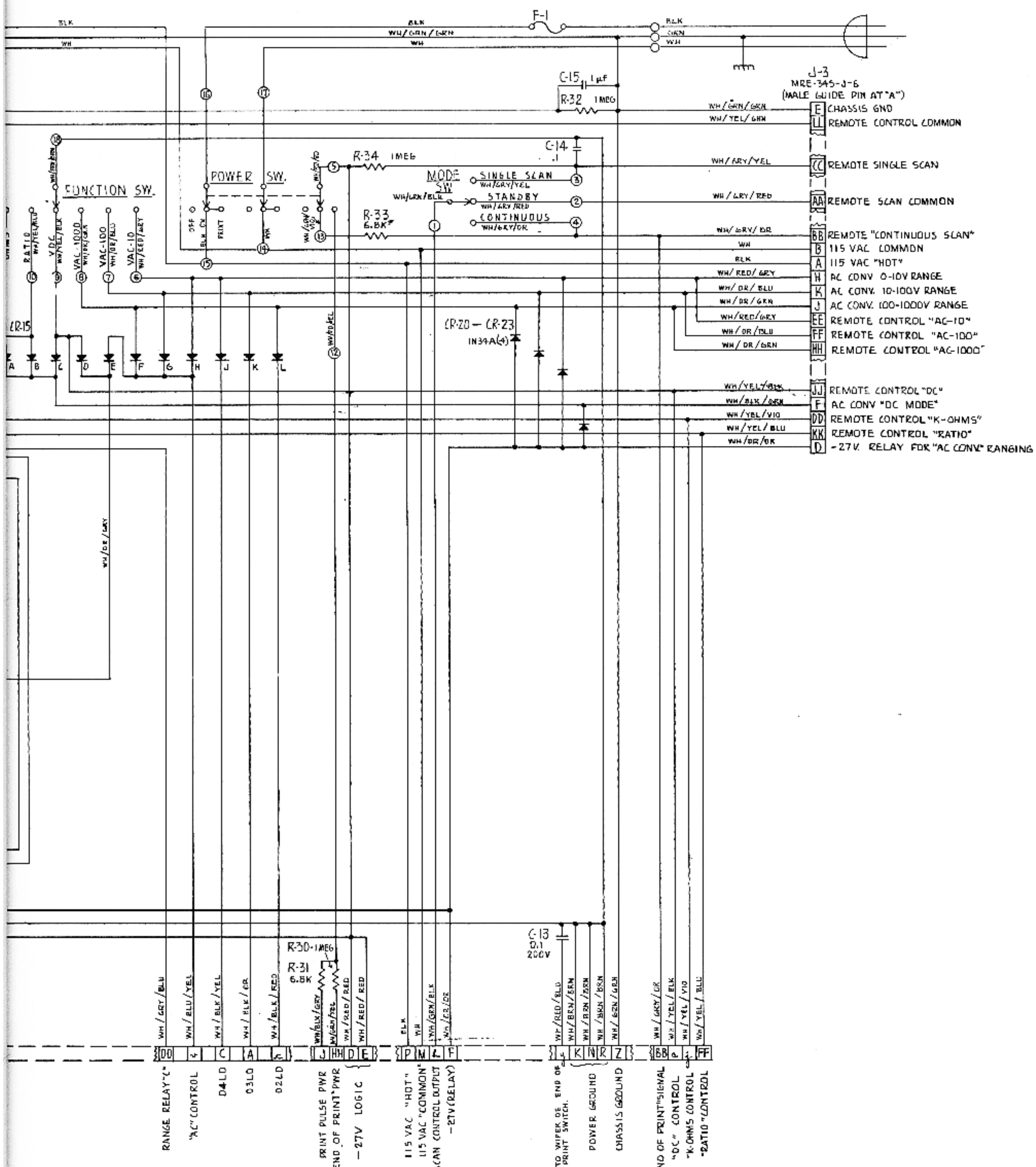
4. ALL RELAYS SHOWN IN DE-ENERGIZED POSITION.
3. ALL DIODES F-6. OR 1N2071.
2. ALL RESISTORS ½ W.
⚠1 SHIELDING TYPICAL K-1 THRU K-4. TIE PIN 6 TO SHIELD GND.

NOTES :- UNLESS OTHERWISE SPECIFIED



INPUT
INPUT COMMON
CHASSIS GND
J-2
BRIDGE
3102A-14S-5S
BRIDGE INPUT
BRIDGE OUTPUT
BRIDGE COMMON
SHIELD GND
J-4
EXT. REF
3102A-14S-2P
SHIELD GND
EXT. REF GND
EXT. REF "-"
EXT. REF "+"
F-1
C-15 1µf
R-32 1MEG
C-14 .1
R-34 1MEG
POWER SW.
FUNCTION SW.
MODE SW
SINGLE SCAN
STANDBY
CONTINUOUS
R-33 6.8K
OHMS
RATIO
VDC
VAC-1000
VAC-100
VAC-10
CR-5 THRU CR-15
CR-20 - CR-23 1N34A(4)
R-14 3.2K
R-15 1600Ω
K-5 (P1)
K-6 (P2)
R-13 100K
R-16 800Ω
R-17 1K
V-5B
R-9
R-10
R-11 2K
R-12 300K
R-42 100K
CR-2 1N34A
K-7 (V)
R-21 1K
CR-3 1N34A
R-25 20K
CR-4 1N3517R
R-26 620Ω
K-8 (Ω)
R-22 9K
R-23 900K
R-24 100K
R-27 2.213K
R-28 17Ω
R-18 9MEG
R-19 .89MEG
R-20 20K
R-29 18K
K-4 (S)
K-1 (A)
K-3 (C2)
K-2 (C1)
C-13 0.1 200V
R-30-1MEG
R-31 6.8K
AMPL.OUTPUT
SCAN RELAY
POLARITY RELAY
RANGE RELAY "A"
RANGE RELAY "C"
"AC" CONTROL
D4LD
D3LD
D2LD
PRINT PULSE PWR
"END OF PRINT" PWR
-27V LOGIC
115 VAC "HOT"
115 VAC "COMMON"
SCAN CONTROL OUTPUT
-27V (RELAY)
TO WIPER OF END OF PRINT SWITCH.
POWER GROUND
CHASSIS GROUND
"END OF PRINT" SIGNAL
"DC" CONTROL

REVISIONS				
SYM	EFFECT	DESCRIPTION	DATE	APPROVAL
1		ADDED CR-20 THRU CR-24 CONNECT. V-5 PIN 5 TO SIG.GND R-14 WAS 2K R15 WAS 800Ω	8 MAY 59 ARW	5-14-59 H Clement
2		ADDED R-43 & R-44	25 MAY 59 ARW	5-25-59 HCa
3		ADDED Q2 & Q3 & CONN. TO PINS 8,9,10,11 & 13 OF AMP.-PWR. SUP. (10050-008) PLUG	6-29-59 HTS	6-29-59 H Clement
4		NOTE 3: 1N 2071 WAS 1N 7021 (ERROR); ADDED NOTE 4; J-1 WAS 3102A-14S-7S (ERROR); ADDED DIR. OF ROT. OF R-8 & R-11; R-8 WIPER WAS CONN. TO PIN 7, V-4; C-8 WAS 3.3μf; K-1, K-2, K-3 & K-4 WERE IN ENERGIZED POS.; CR-20-CR-23 WAS CR-20-CR-24 (ERROR); CR20-CR13 SYMBOLS WERE REVERSED (ERROR); REV 2 WAS ADDED R-43 & R-34 (ERROR)	7-16-59 HTS	7/17/59 H Clement



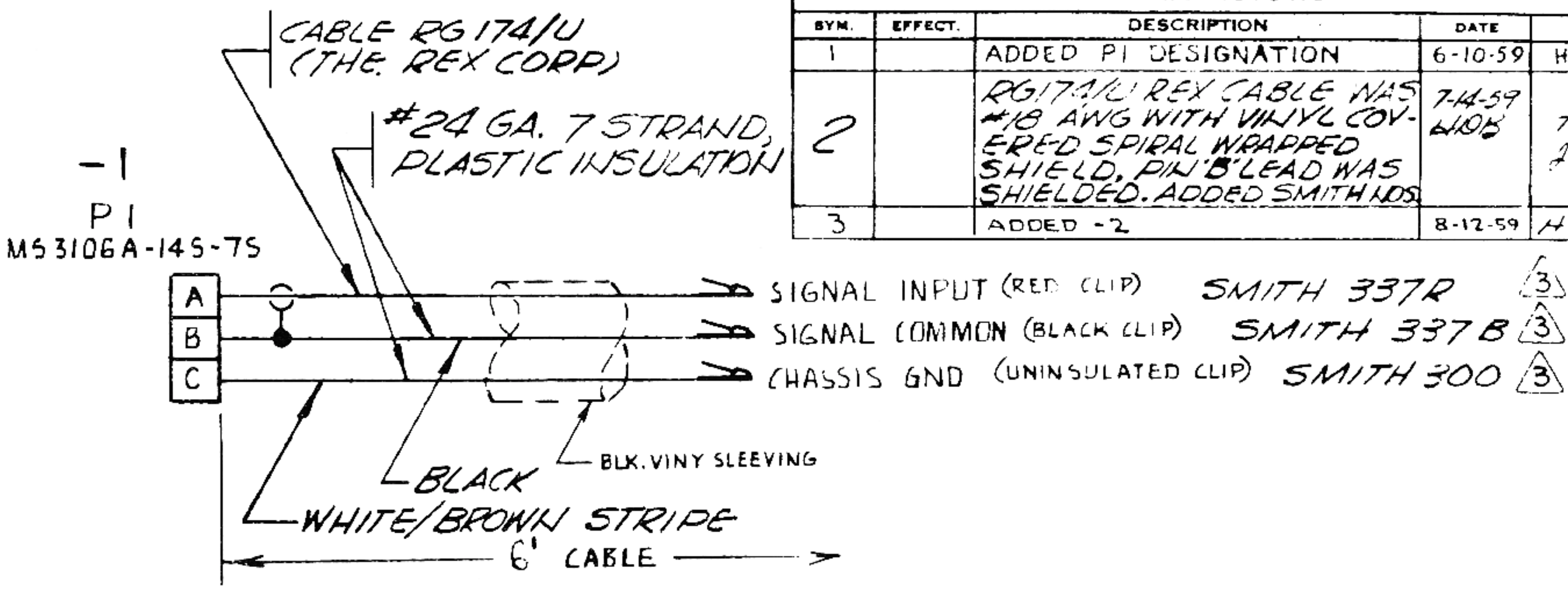
10050-035
SHEET 2

4

UNLESS OTHERWISE SPECIFIED	DRAWN BY A.R. WALLIN	DATE 10 MAR '59	TITLE SCHEMATIC- B UNIT	NON-LINEAR SYSTEMS INC. DEL MAR AIRPORT DEL MAR, CALIFORNIA
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	CHECKED BY J. CLEMENT	DATE 27 MAR 59		DRAWING NUMBER 10050-035
	APPROVED BY H Clement	DATE 3-31-59		
MATERIAL	FINISH		SCALE / WT.	SHEET 2 OF

DRAWING NUMBER 15004-075 | 3

REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		ADDED P1 DESIGNATION	6-10-59	H.L.C.
2		RG174/U REX CABLE WAS #18 AWG WITH VINYL COVERED SPIRAL WRAPPED SHIELD, PIN "B" LEAD WAS SHIELDED. ADDED SMITH NOS.	7-14-59	7-14-59
3		ADDED -2	8-12-59	H Clement



3 -2: SAME AS -1 EXCEPT USE SPADE LUGS - NO. 2600 (VACO) -3 REQ IN PLACE OF CLIPS (SMITH 300, 337B & 337R)

2. MARK OR STAMP PART NO. & "CABLE-INPUT" ON ALUM. TAG #9-1639 NATIONAL TAG CO. OR EQUIV & ATTACH TO CABLE.

1. CONNECTORS TO HAVE GOLD CONTACTS & DAP INSULATION

NOTE: UNLESS OTHERWISE SPECIFIED

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
11400	11400	1	1
10050	10050	1	1
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	DRAWN BY A. R. WALLIN — DATE 26 MAR '59 CHECKED BY J. M. CLEVELAND — DATE 27 MAR 59 APPROVED BY H Clement — DATE 27-Mar-59	TITLE CABLE, INPUT MODEL 24 & 34
MATERIAL	FINISH	SCALE — WT.

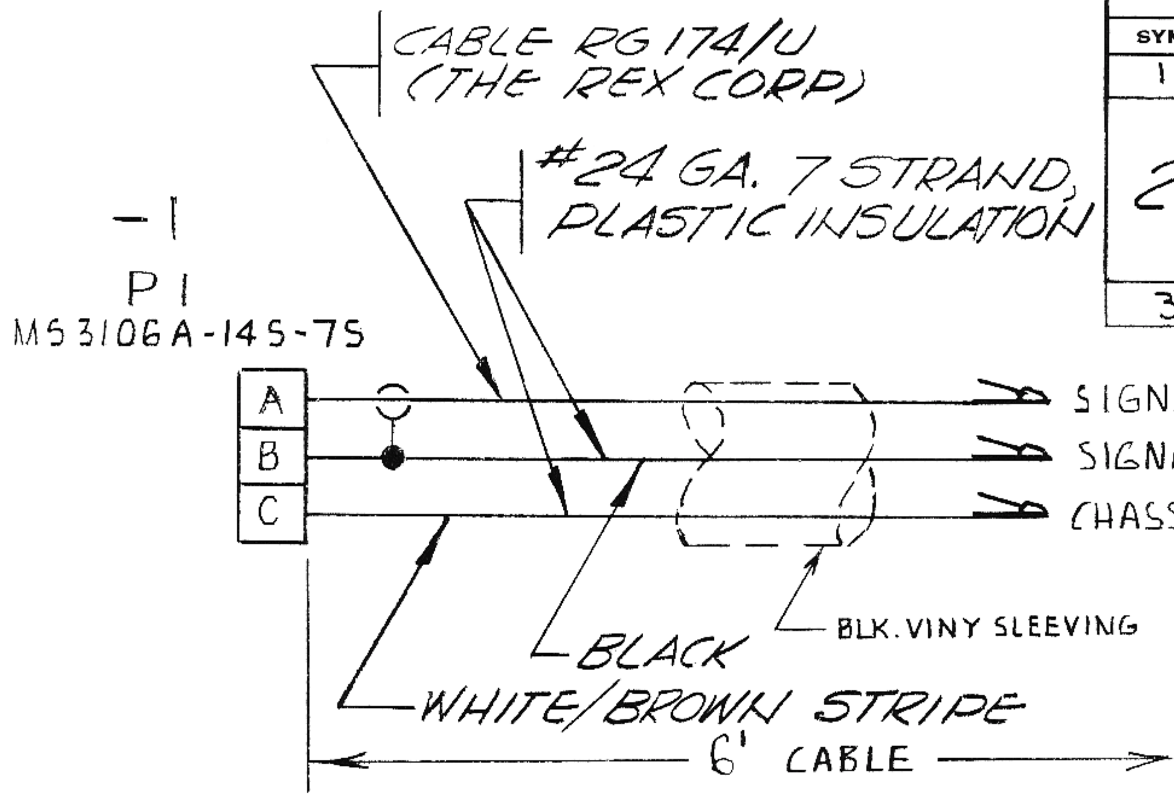
NON-LINEAR SYSTEMS INC.
DEL MAR, CALIFORNIA

DRAWING NUMBER 15004-075

SHEET OF

www.everything4lessstore.com

SYM.	EFFECT.	
1		A
2		[illegible]
3		A



△3 -2: SAME AS -1 EXCEPT USE SPADE LUGS - NO. 2600 (
-3 REQ IN PLACE OF CLIPS (SMITH 300, 337B & 337R)

2. MARK OR STAMP PART NO. & "CABLE - INPUT" ON ALUM. TAG #9-1639 NATIONAL TAG CO. OR EQUIV & ATTACH TO CABLE.

1. CONNECTORS TO HAVE GOLD CONTACTS & DAP INSULATION

NOTE: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED	DRAWN BY A. R. WALLIN	DATE 26 MAR '59	TITLE
DIMENSIONS ARE IN INCHES	CHECKED BY JIM CLEMENT	DATE 27 MAR '59	CABLE,
TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	APPROVED BY H Clement	DATE 27-Mar-59	
MATERIAL	FINISH		MODEL 2
			SCALE

DRAWING NUMBER 15004-075 | 3

REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		ADDED P1 DESIGNATION	6-10-59	H.L.C.
2		RG174/U REX CABLE WAS #18 AWG WITH VINYL COVERED SPIRAL WRAPPED SHIELD, PIN "B" LEAD WAS SHIELDED. ADDED SMITH NOS.	7-14-59 6110B	MTS 7-14-59 J.C.
3		ADDED -2	8-12-59	H Clement

STRAND,
SULATION

SIGNAL INPUT (RED CLIP) SMITH 337R 3

SIGNAL COMMON (BLACK CLIP) SMITH 337B 3

CHASSIS GND (UNINSULATED CLIP) SMITH 300 3

K. VINY SLEEVING

TRIPE

LE

SPADE LUGS – NO. 2600 (VACO)
SMITH 300, 337B & 337R)
ON ALUM. TAG #9-1639
ABLE.
& DAP INSULATION

APPLICATION		QTY REQD	
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
11400	11400	1	1
10050	10050	1	1

ATE MAR'59
ATE MAR'59
ATE MAR'59

TITLE

CABLE, INPUT

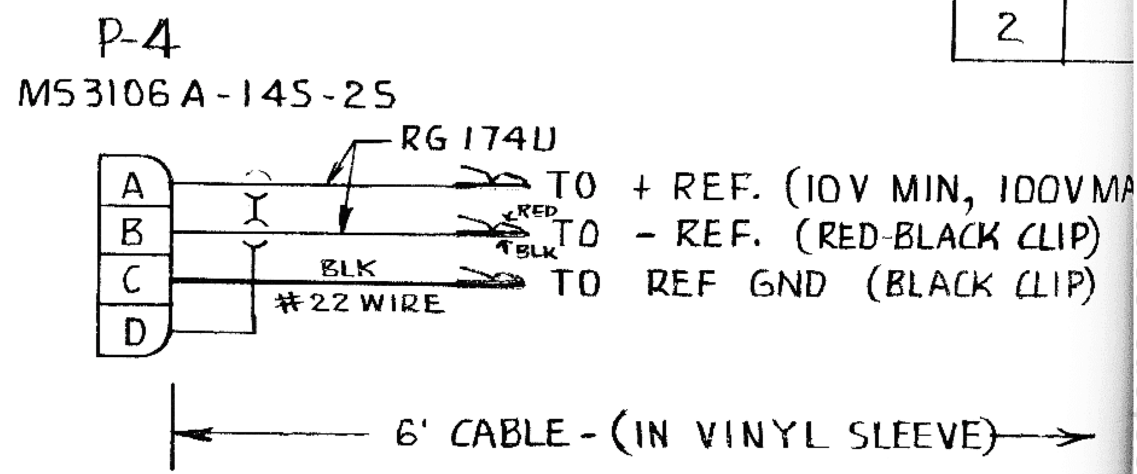
MODEL 24 & 34

NLS NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER 15004-075

SCALE | WT. | SHEET OF

SYM.	EFFE
1	
2	



1. MARK OR STAMP PART NO. & "EXTERNAL REF. TO B UNIT" ON ALUM. TAG - #9-1639 NATIONAL TAG COMPANY OR EQUIV & ATTACH TO CABLE.

NOTES: UNLESS OTHERWISE SPECIFIED —

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTION ± DECIMAL ± ANGLES ±

MATERIAL

DRAWN BY A. R. WALLIN — DATE 26 MAR '59
CHECKED BY JIM CLEMENT — DATE 27 MAR '59
APPROVED BY H Clement — DATE 27 Mar 59

FINISH

TITLE
CAB
EXTERNAL

SCALE

DRAWING NUMBER	
15004-077	2

REVISIONS

SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		ADDED P4 DESIGNATION	6-10-59 DAS	H. L. C.
2		WAS 6' CABLE - MOHAWK #5254 P4-C TO REF GND WAS SHIELDED	11-10-59 ARW	11-12-59 H Clement

F. (10V MIN, 100V MAX) (RED CLIP)
F. (RED-BLACK CLIP)
GND (BLACK CLIP)

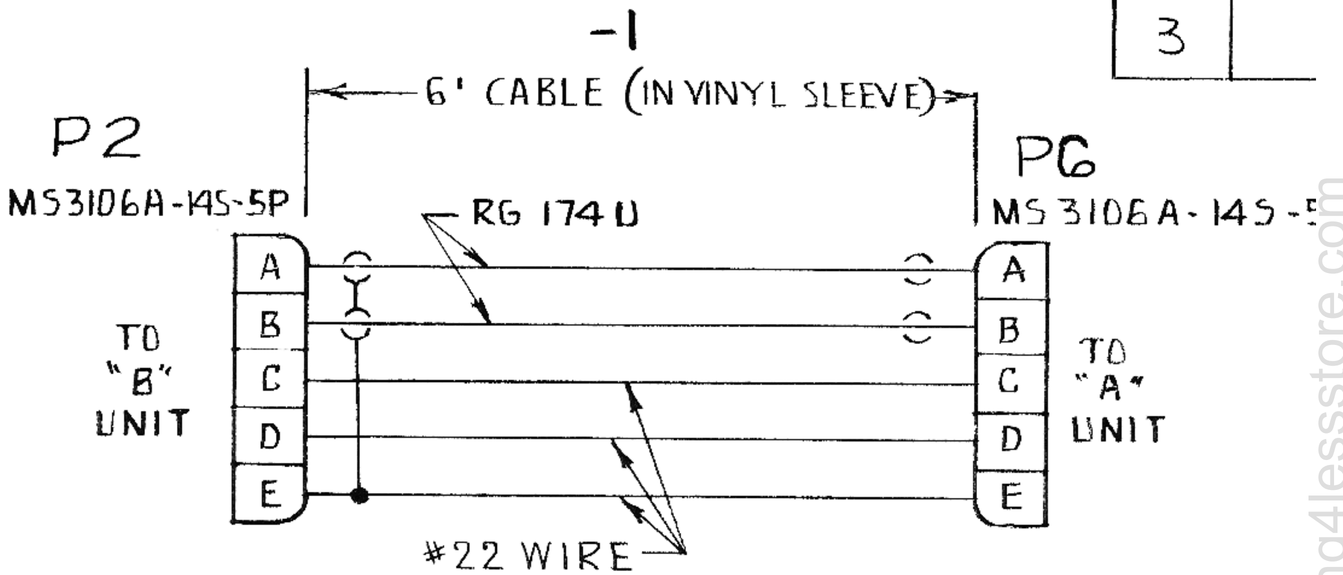
NYL SLEEVE) →

AL REF.
39 NATIONAL
TO CABLE.

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

	TITLE	
E AR '59 E AR '59 E MAY 59	CABLE, TEST - EXTERNAL REF. TO "B" UNIT	NON-LINEAR SYSTEMS INC. DEL MAR AIRPORT DEL MAR, CALIFORNIA
	SCALE / WT.	DRAWING NUMBER 15004-077 SHEET OF

SYM.	EFFE
1	
2	
3	



1. MARK OR STAMP 15004-078 & "REFERENCE CABLE" ON ALUM TAG #9-1639 NATIONAL TAG CO. OR EQUIV & ATTACH TO CABLE

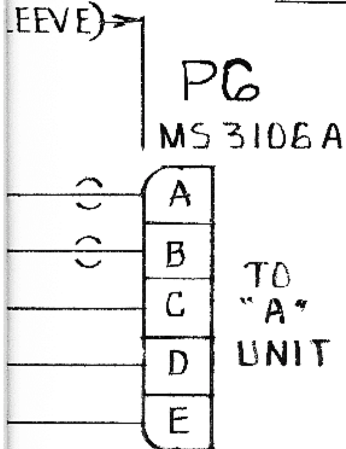
NOTES: UNLESS OTHERWISE SPECIFIED —

UNLESS OTHERWISE SPECIFIED	DRAWN BY A. R. WALLIN	DATE 26 MAR '59	TITLE
DIMENSIONS ARE IN INCHES	CHECKED BY JIM CLEMENT	DATE 27 MAR '59	CA
TOLERANCES ON FRACTION ± DECIMAL ± ANGLES ±	APPROVED BY H Clement	DATE 27-Mar-59	REFER
MATERIAL	FINISH		"A" UNIT
			SCALE

DRAWING NUMBER 15004-078 | 3

REVISIONS

SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		ADDED -2 & "P" NO'S		H.L.C.
2		P2 WAS P5	6-10-59 DAS	H.L.C.
3		WAS 6' CABLE MOHAWK #5254 P2-C & D TO P-6 C & D WERE SHLD'D	11-10-59 ARW	11-12-59 H Clement



-2 SAME AS -1 EXCEPT 2' LONG

FERENCE
TIONAL TAG
BLE

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

DATE 26 MAR'59
DATE 27 MAR'59
DATE 27-Mar 59

TITLE
CABLE - REFERENCE
"A" UNIT TO "B" UNIT

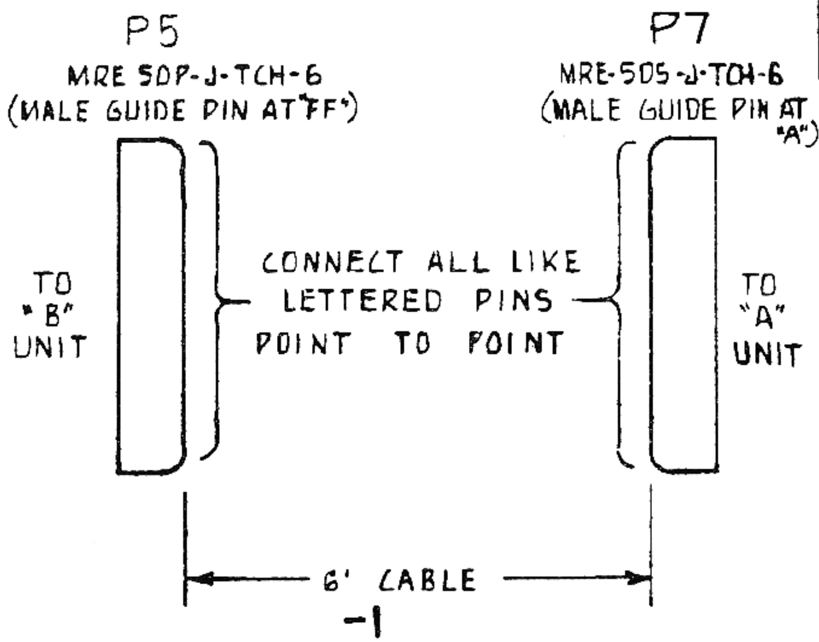
NON-LINEAR SYSTEMS INC.
DEL MAR AIRPORT
DEL MAR, CALIFORNIA

DRAWING NUMBER 15004-078

SCALE | WT. | SHEET OF

DRAWING NUMBER 15004-079 | 2

REVISIONS				
SYM.	EFFECT.	DESCRIPTION	DATE	APPROVAL
1		ADDED -2 & "P" NO'S	5-21-59	H.L.C.
2		P5 WAS P2	6-10-59 DAS	H.L.C.



-2 SAME AS -1 EXCEPT 2' LONG & USES RIGHT ANGLE HOODS, MRE 50H-1(JTC); CABLE OUTLET SAME END AS PIN "A"

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

1. MARK OR STAMP 15004-079 & "POWER & LOGIC CABLE" ON CONNECTOR HOOD.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTION ± DECIMAL ± ANGLES ±

MATERIAL

DRAWN BY A. R. WALLIN — DATE 26 MAR '59
CHECKED BY JIM CLEMENT — DATE 27 MAR 59
APPROVED BY H Clement — DATE Mar 27-59

FINISH

TITLE
CABLE-
POWER & LOGIC
"A" UNIT TO "B" UNIT

SCALE | WT.

NON-LINEAR SYSTEMS INC.
DEL MAR, CALIFORNIA

DRAWING NUMBER 15004-079

SHEET OF

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